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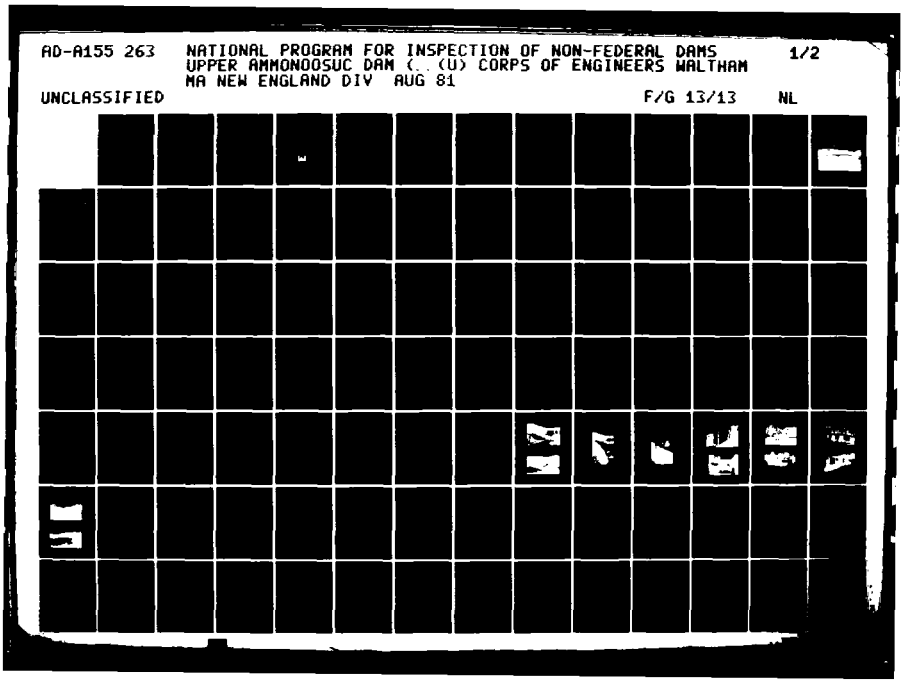

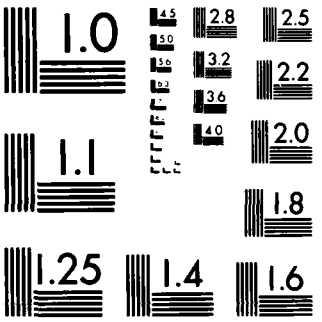

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CONNECTICUT RIVER BASIN

NORTHUMBERLAND, NEW HAMPSHIRE

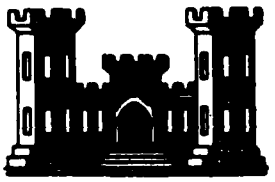
UPPER AMMONOOSUC DAM

NH 00370

NHWRB 182.04

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

AUGUST 1981

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Northumberland, New Hampshire
Upper Ammonoosuc River, tributary of the Connecticut River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is constructed of rock and earth filled timber cribbing and is equipped with 6.2 ft. of nonfailing flashboards. It is about 275 ft. long and 15 ft. high. It is small in size with a high hazard potential. One half of the PMF has been adopted as the appropriate test flood. The dam is in fair condition at the present time. There are various remedial measures which require attention.

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NATIONAL DAM INSPECTION

PHASE I INSPECTION REPORT

Identification No.:	NH00370
NHWRB No.:	182.04
Name of Dam:	Upper Ammonoosuc Dam
Town:	Northumberland
County and State:	Coos, New Hampshire
Stream:	Upper Ammonoosuc River, tributary of the Connecticut River
Date of Inspection:	May 14, 1981

BRIEF ASSESSMENT

The Upper Ammonoosuc Dam, also known as Red Dam, is located on the Upper Ammonoosuc River, approximately one mile upstream of the village of Groveton, New Hampshire. State Route 110 passes the left abutment of this dam.

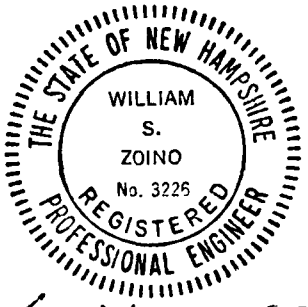
The dam is constructed of rock and earth filled timber cribbing and is equipped with 6.2 feet of nonfailing flashboards. It is capable of impounding a maximum of 725 acre-feet. The overall length of the dam is approximately 275 feet, and the maximum height is 15 feet. There are four 7-foot-wide wastegates at the right abutment, and there is one 9.5-foot-wide wastegate at the left abutment. The overflow spillway has a weir length of approximately 155 feet.

The original design and construction are unknown. According to the records of the New Hampshire Water Resources Board, the dam was constructed prior to 1920. The four gates at the right abutment were installed in 1973. The dam serves to impound water to maintain the level behind the dam downstream, which provides process water to the owner, the Groveton Paper Company.

The drainage area for this dam consists of 247 square miles of rolling to mountainous forest. The dam is SMALL in size and its hazard potential classification is HIGH, since appreciable economic loss and loss of more than a few lives could result from the event of a dam failure. The appropriate Test Flood for a dam classified small in size with a high hazard classification would be between one-half the Probable Maximum Flood (PMF) and the Probable Maximum Flood. One-half of the PMF has been adopted as the appropriate Test Flood.

The one-half PMF inflow is 86,500 cfs. Attenuation due to storage in the reservoir is negligible. The Test Flood outflow is 86,500 cfs, with the water surface at elevation 907.4 feet (NGVD), which is 15.1 feet above the top of the dam. The spillway is capable of passing 9% of the Test Flood routed peak outflow without overtopping.

The dam is in FAIR condition at the present time. It is recommended that the owner retain the services of a qualified registered professional engineer to conduct a detailed hydraulic and hydrologic study to further define the need for and means to increase the project discharge capacity and the ability of the dam to withstand overtopping; to conduct a detailed inspection of the spillway under low flow conditions; and to evaluate the condition of the left abutment and make recommendations for its restoration. Remedial measures to be undertaken by the owner include implementing annual maintenance and inspection programs, and developing a plan for dam surveillance during flood periods and a formal, written system for warning downstream residents and appropriate officials in the event of an emergency. These engineering studies and remedial measures should be implemented by the owner within one year of receipt of this Phase I Inspection Report.



William S. Zoino
NH Registration No. 3226

Nicholas A. Campagna, Jr.
California Registration No. 21006

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C., 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need from such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no trespassing signs, repairs to existing fences and railings, and other items which may be needed to minimize trespassing and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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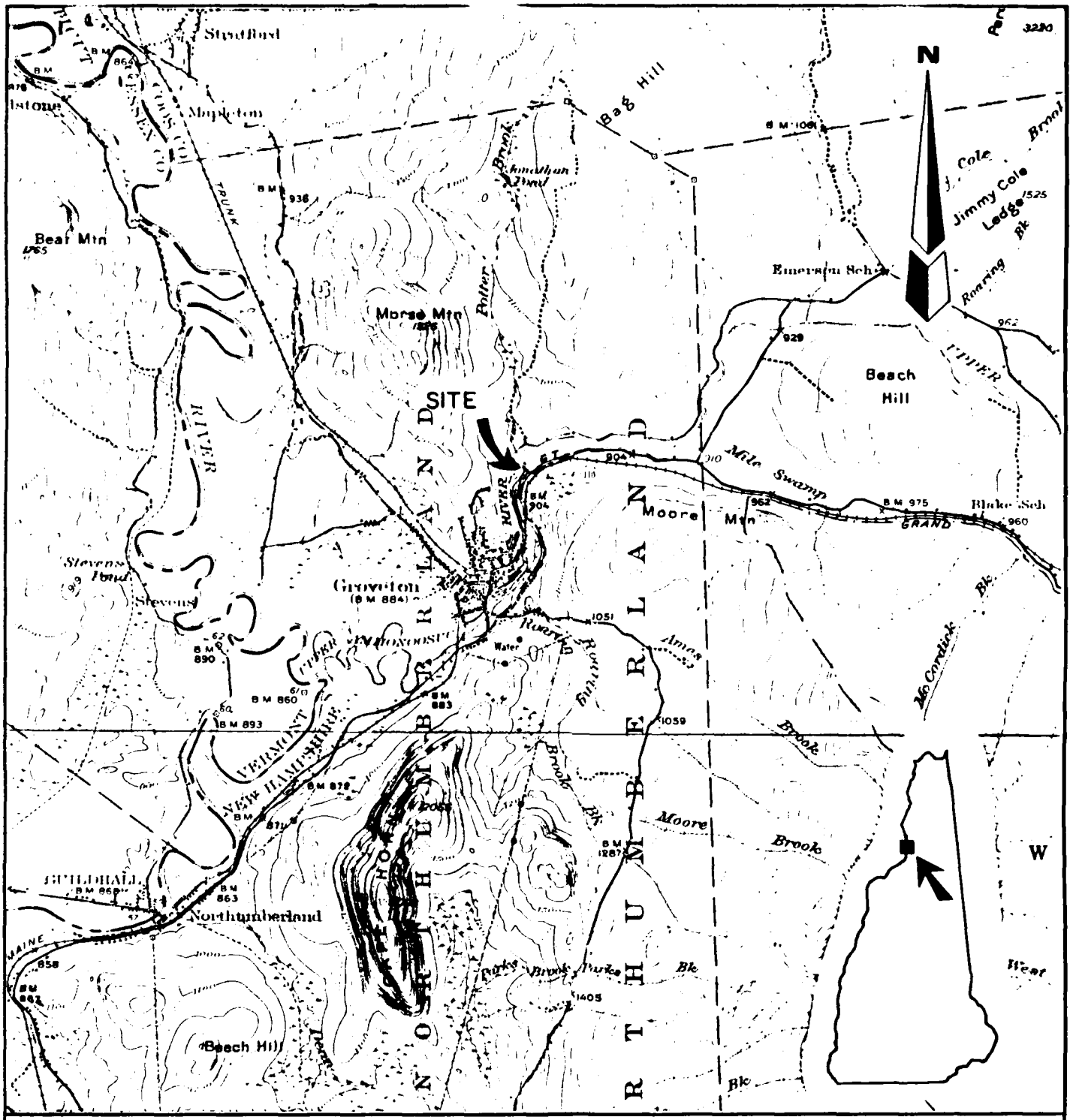
APPENDICES

Overview of Dam



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GOLDBERG · ZOINO & ASSOCIATES, INC.
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCUS PLAN

FILE No. 2605

UPPER AMMONOOSUC RIVER DAM

GROVETON, NEW HAMPSHIRE

SCALE AS NOTED

DATE MAY 1981

National Dam Inspection Program

Phase I Inspection Report

Upper Ammonoosuc Dam

Section 1: Project Information

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg-Zoino & Associates, Inc. (GZA) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to GZA under a letter of April 29, 1981, from Colonel William E. Hodgson, Jr., Corps of Engineers. Contract No. DACW 33-80-C-0055 has been assigned by the Corps of Engineers for this work.

(b) Purpose

(1) Perform technical inspection and evaluation of nonfederal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by nonfederal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for nonfederal dams.

(3) Update, verify, and complete the National Inventory of Dams.

1.2 Description of Dam

(a) Location

The Upper Ammonoosuc Dam is located on the Upper Ammonoosuc River, approximately one mile upstream of the village of

Groveton, New Hampshire, and three miles upstream of the confluence with the Connecticut River. It can be reached from State Route 110, which passes near the left abutment of the dam. The dam is shown on U.S.G.S. Guildhall-VT-NH Quadrangle at approximate coordinates N44 36.6', W71 30.4' (see location map on Page vi). Page B-2 of Appendix B is a site plan for this dam.

(b) Description of Dam and Appurtenances

The dam is constructed of rock and earth filled timber cribbing. The spillway is approximately 155 feet long and is constructed of wood planking which is supported by buttresses 2.5 feet on center. There is one gate at the left abutment and there are four gates at the right abutment, to control flow. The overall length of the dam is approximately 275 feet.

(1) Spillway

The spillway consists of a permanent timber crib section topped by braced flashboards, 6.2 feet high. The buttresses are constructed of 4-inch by 6-inch timbers and are spaced roughly 2.5 feet apart. The permanent spillway crest is approximately 4.5 feet above the streambed. A wood apron extends approximately 7 feet downstream of the spillway. The spillway crest has a weir length of approximately 155 feet.

(2) Left Gate Structure

A timber crib structure at the left end of the spillway includes a vertical lift slide gate. The gate opening is 9.5 feet wide and the gate is 10 feet high. It is operated by a chain fall from above. The timber crib between the gate and the spillway is 7.5 feet wide, 8 feet long and 13 feet high. The timber crib to the left of the gate is 24 feet wide, 40 feet long and 13 feet high. This crib meets the left abutment at the highway, which is cut into natural ground.

(3) Right Gate Structure

A timber crib structure extends from the spillway to the right abutment. This crib is 66 feet wide

and 20 feet long. The top of this structure is approximately the same elevation as the top of the left gate structure. This crib houses four vertical lift slide gates which are each 8 feet wide and 9 feet high. The gate openings are 7 feet wide.

The gates are operated by wheel operated gears. Two electric motors are available to provide powered lift, if necessary.

(c) Size Classification

The dam has a maximum impoundment of 725 acre-feet and a height of 15 feet. According to the Corps of Engineers' Recommended Guidelines, a small size dam has a maximum storage between 50 and 1,000 acre-feet or a height between 25 feet and 40 feet. Therefore, this dam is classified as SMALL, based on its storage.

(d) Hazard Classification

The hazard potential classification for this dam is HIGH because of the appreciable economic losses and potential for loss of more than a few lives downstream in the event of dam failure. Ten houses approximately 4,000 feet downstream would experience approximately one foot of prefailure flooding. The failure flood at these houses would be on the order of 3 feet. Section 5 of this report presents a more detailed discussion of the hazard potential.

(e) Ownership

The dam is owned by the Groveton Paper Company, Groveton, New Hampshire. Mr. Walter Taylor, the chief engineer, can be reached by telephone at (603) 636-1154, extension 227.

(f) Operator

The operation of the dam is controlled by the Groveton Paper Company, Groveton, New Hampshire. Mr. Walter Taylor, the chief engineer, can be reached by telephone at (603) 636-1154, extension 227.

(g) Purpose of Dam

The purpose of the dam is to impound water for temporary storage. This water is released to maintain the level behind a dam downstream, which supplies process water to the paper mill.

(h) Design and Construction History

The dam was originally constructed around 1920. At that time, it had a 200-foot spillway and two waste gates at the right abutment. In 1972, a gate structure housing four gates was installed at the right abutment. Each of these gate openings is 7 feet wide. At the left abutment is a waste gate 9.5 feet wide which was installed prior to 1972. These changes reduced the spillway crest length to approximately 155 feet.

(i) Normal Operating Procedure

No formal operating procedures exist for this dam. The waste gates are normally partially open.

1.3 Pertinent Data

(a) Drainage Area

The drainage area for this dam covers 247 square miles. It is made up primarily of rolling to mountainous forest.

(b) Discharge at Dam Site

(1) Outlet Works

The outlet works for this dam consist of four vertical lift gates at the right abutment and one gate at the left abutment. The right abutment gate openings are each 7 feet wide, with an invert elevation at 879.3 feet NGVD. Each gate will pass approximately 640 cfs with the reservoir at top-of-dam elevation (892.3 feet NGVD). The left gate is 9.5 feet wide, with an invert elevation of 888.1 feet NGVD. The left gate will pass approximately 1,000 cfs with the reservoir at top-of-dam elevation.

(2) Maximum Known Flood

A USGS gauge (2.5 miles upstream) indicated a peak flow on May 20, 1969, of 24,100 cfs.

(3) Ungated Spillway Capacity at Top of Dam

The capacity of the spillway with the reservoir at top-of-dam elevation (892.3 feet NGVD) is 4,280 cfs.

(4) Ungated Spillway Capacity at Test Flood

The Test Flood overtops the dam by 15.1 feet. The discharge above the spillway at this level (907.4 feet NGVD) is 41,060 cfs.

(5) Gated Spillway Capacity at Normal Pool

There are no gated spillways.

(6) Gated Spillway Capacity at Test Flood

There are no gated spillways.

(7) Total Spillway Capacity at Test Flood

The discharge above the spillway at Test Flood elevation (907.4 feet NGVD) is 41,060 cfs.

(8) Total Project Discharge at Top of Dam

The total project discharge at top-of-dam elevation (892.3 feet NGVD) is 7,840 cfs with all of the waste gates open.

(9) Total Project Discharge at Test Flood Elevation

The total project discharge at Test Flood elevation (907.4 feet NGVD) is 86,500 cfs.

(c) Elevation

(1) Streambed at toe of dam: Approximately 877.3

(2) Bottom of cutoff: Unknown

(3) Maximum tailwater: Unknown

(4) Normal pool: Approximately 888.0

(5) Full flood control pool: Not applicable

(6) Spillway crest: Approximately 881.8
with flashboards: 888.0

(7) Design surcharge: Unknown

(8) Top of dam: 892.3

(9) Test flood surcharge: 907.4

(d) Reservoir (length in feet)

This is a run-of-the-river dam with a reservoir length of approximately 10,000 feet.

(e) Storage (acre-feet)

(1) Normal pool: 400

(2) Flood control pool: Not applicable

(3) Spillway crest pool: 400

(4) Top of dam pool: 725

(5) Test flood pool: 1,930

(f) Reservoir Surface (acres)

This is a run-of-the-river dam with a reservoir surface area of approximately 75 acres.

(g) Dam

(1) Type: Gravity, overflow, timber crib with earth and rock fill

(2) Length: Approximately 275 feet

(3) Height: Approximately 15 feet

(4) Top width: Variable

(5) Side slopes: Not applicable

(6) Zoning: Not applicable

(7) Impervious core: Not applicable

(8) Cutoff: Unknown

(9) Grout curtain: Unknown

(h) Diversion and Regulating Tunnel

Not applicable

(i) Spillway

(1) Type: Timber, broad crested weir

(2) Length of weir: 155 feet

(3) Crest elevation: 881.8 feet (NGVD)

(4) Gates: None, nonfailure flashboards to elevation 888.0 feet.

(5) Upstream channel: Upper Ammonoosuc River

(6) Downstream channel: Upper Ammonoosuc River

(j) Regulating Outlets

The regulating outlets at this dam consist of four gates at the right abutment and one gate at the left abutment. The gates at the right abutment are each 7 feet wide, with an invert elevation of approximately 879.3 feet (NGVD). The gate at the left abutment is 9.5 feet wide, with an invert elevation of 881.8 feet (NGVD).

Section 2: Engineering Data

2.1 Design Data

None of the original design drawings or calculations are available for this dam. Lacking are data concerning the length and depth of any cutoff and the foundation conditions.

2.2 Construction Records

No construction records are available for this dam.

2.3 Operational Records

No operational records are available for this dam.

2.4 Evaluation of Data

(a) Availability

The lack of detailed design and construction data warrants an unsatisfactory assessment for availability.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment of the dam is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Validity

The observations of the inspection team generally confirm the information contained in the records of the New Hampshire Water Resources Board. Therefore, a satisfactory evaluation for validity is indicated.

Section 3: Visual Inspection

3.1 Findings

(a) General

The Upper Ammonoosuc Dam is in fair condition at the present time.

(b) Dam

(1) Left Abutment (See Photos 1,2 3, 4, 5, 6, and 7)

This structure is constructed with timber cribbing and sheeting, filled with boulders and gravel, and houses a waste gate. The main supporting members are generally 15-inch-diameter logs laid up horizontally, with 3-inch planking fastened in the vertical position. The outboard end of this structure consists of square logs and horizontal planking. Visual observations revealed that the horizontal logs, the vertical planking, and the outboard crib are partially rotted. Vertical planks are missing, and there is evidence of ground erosion. Two sinkholes were noted at the downstream end (see Photo 3). Considerable seepage (50 to 100 GPM) is passing through the outboard crib.

The steel pipe rail around this structure is in good condition.

(2) Spillway (See Photos 1 and 3)

Observation revealed that the downstream buttresses of this structure are well aligned. The spillway shows no evidence of distress and appears to be well-maintained. A complete inspection could not be accomplished due to sheet flow, and it is recommended that this structure be inspected under low flow conditions.

(3) Right Abutment (See Photos 2 and 8)

This timber crib structure is constructed with 12-inch-square members, laid horizontally, and filled with boulders and gravel. It houses four waste gates. The entire upstream face of this structure and the

upstream side walls of the waste gate openings are faced with 3/8-inch steel plate. Wood planking has been fastened to the top of the structure. Visual observations revealed that this structure is in good condition, with no any evidence of rot or distress.

Two electric motors are installed to service two gates each. These motors can be attached by chain drive to provide assistance for lifting the gates. They appear to be in good condition.

(4) Waste Gate - Left Abutment (See Photos 2, 6, and 7)

This gate is fabricated from steel plate 3/8 inch thick, and is horizontally backed with four 4-inch I beams. Gate guides are fabricated from steel angles. Operation of this gate is manually performed by means of a chainfall. The chainfall is hung from an inverted "U" frame fabricated from structural steel. The gate and the operating assembly are well maintained. Observations revealed that this gate is not fully seated.

Personnel were not available for testing the operation of the gate. According to the owner's representative, the gate is operable.

(5) Waste Gates - Right Abutment (See Photos 2, 8, 9, and 10)

These gates are fabricated from 3/8-inch steel plate and backed with horizontal members. The guides are fabricated from steel channels. The gate stems (two per gate) are fabricated from rectangular, tubular steel, which is through-bolted to rack gears. Operation of the gates may be performed manually or with a motor drive system. The gates and operating mechanisms are in good condition.

Personnel were not available for testing the operation of the gates. According to the owner's representative, the gates are operable.

(c) Reservoir Area (See Photos 1, 3, 7, and 11)

The shore of the reservoir area is generally shallow to moderately sloping woodland. A state highway passes along the left bank. The shores appear stable and in good condition.

(d) Downstream Channel (See Photos 2 and 12)

The downstream channel is the Upper Ammonoosuc River, which is wide and shallow and leads to the impoundment of another dam at the paper mill.

3.2 Evaluation

The spillway, the right abutment, and all gates, including the operating mechanisms, appear to be in good condition. The only problem area noted during the visual inspection was the partial decay of the timber cribs and erosion at the left abutment. The spillway structure should be inspected under low flow conditions, and the operation of each gate should be inspected over its full range.

Section 4: Operational and Maintenance Procedures

4.1 Operational Procedures

(a) General

No written operational procedures exist for this dam. The waste gates are normally partially open.

(b) Description of any Warning System in Effect

There is no warning system in effect at this dam.

4.2 Maintenance Procedures

(a) General

No formal maintenance program exists for the dam, and maintenance is performed on an "as needed" basis.

(b) Operating Facilities

No formal maintenance program exists, and maintenance is performed on an "as needed" basis

4.3 Evaluation

Additional emphasis on routine maintenance will assist the owner in assuring the long-term safety of the dam and operating facilities. A formal, written, downstream emergency warning system should be developed for this dam.

Section 5: Evaluation of Hydraulic/Hydrologic Features

5.1 General

The Upper Ammonoosuc Dam, also known as the Red Dam, is an earth and rock filled and timber crib structure on the Upper Ammonoosuc River in the town of Northumberland, New Hampshire. Although the dam is essentially a run-of-the-river type, it forms a pond of about 74 acres. The dam is located about 3 miles upstream of the confluence with the Connecticut River and about one mile upstream of the village of Groveton. It is the first in a series of three dams along the river in Groveton.

The spillway consists of a permanent timber crib section topped by braced flashboards, 6.2 feet high. The overall spillway crest length is 155 feet at an elevation of 888.0 feet (NGVD). The abutments are earth and rock filled timber crib structures with one gate in the left abutment and four gates in the right abutment. The gate on the left (invert at 991.2) has a width of 9.5 feet and may be lifted 10.5 feet to the top of its guide slots at the dam crest. The gates on the right have inverts at 879.3 feet and have gate openings of 7 feet by 6 feet when fully open. All gates appear to be in good operating condition.

The tailwater at the Upper Ammonoosuc Dam is established by ponding behind the Brookland Dam, located about 4,500 feet downstream. In the reach between these two dams, the river is wide and flat, with riverbank heights generally only 3 feet to 8 feet above normal water levels. Significantly, residential and industrial development in Groveton exists in the broad, flat overbank areas of this reach, particularly in the vicinity of the Brookland Dam.

Downstream of the Brookland Dam, the river is confined within higher banks in passing through the remainder of Groveton, which includes a major highway bridge, another dam (now deteriorated and of little consequence), and a railroad bridge. Little development occurs in this reach.

5.2 Design Data

The basic data available for the Upper Ammonoosuc Dam is given in the New Hampshire Water Resources Board's "Inventory of Dams and Waste Power Developments," dated August 10, 1936; the Public Service Commission of New Hampshire's "Dam Record" of August 19, 1936; and the New Hampshire Water Control Commission's

"Data on Dams in New Hampshire" (undated). Also available are an October 1972 "Dam Safety Inspection Report," by the New Hampshire Water Resources Board, and a July 1980 "Site Evaluation Data" report for the U.S. Army Corps of Engineers. None of the original design plans or plans of modifications to the dam were available.

5.3 Experience Data

A USGS gauge located on the Upper Ammonoosuc River about 2.5 miles upstream of the dam (drainage area = 232 square miles = 94% of that of the dam) has been in operation since August 1940. The maximum recorded discharge of 24,100 cfs (stage of 12.0 feet) was obtained on May 20, 1969. Discussions with the owner did not reveal the effects of this flood. The second highest flood was in March 1936. The discharage during that flood is unknown.

5.4 Test Flood Analysis

The hydrologic conditions of interest in this Phase I Inspection are those required to assess the dam's overtopping potential and its ability to allow an appropriately large flood to pass safely. The evaluation of the impact of an appropriately sized Test Flood requires use of the discharge and storage characteristics of the structure. None of the original hydraulic and hydrologic design analysis was available for this dam.

Guidelines for establishing a recommended Test Flood based on the size and hazard classification of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. The impoundment of less than 1,000 acre-feet and the height of less than 40 feet classify this dam as a SMALL structure. Its hazard classification is HIGH.

As shown in Table 3 of the "Recommended Guidelines," the appropriate Test Flood for a dam classified as small in size with a high hazard potential would be between one-half the Probable Maximum Flood (PMF) and the PMF. Since the height of 15 feet and impoundment of 400 acre-feet are on the low side of the small size classification, one-half of the Probable Maximum Flood has been adopted as the appropriate Test Flood for this dam.

The Corps of Engineer's guidelines for "Maximum Probable Flood Peak Flow Rates" give PMF rates of 700 cfs per square mile (CSM) for rolling topography and 850 CSM for mountainous topography, for a drainage area of 247 square miles. Selecting

700 CSM as most applicable for the entire drainage area yields a peak PMF flow of 173,000 cfs. No attenuation of large flood flows would occur in the small ponding area behind the dam. Therefore, the routed Test Flood outflow (one-half PMF) for Upper Ammonoosuc Dam would be 86,500 cfs. This flow would produce a flood stage 19.4 feet above the spillway, or 15.1 feet over the dam crest. The spillway capacity (including flow through the gates) of 7,900 cfs is only 9% of the peak Test Flood outflow of 86,500 cfs.

5.5 Dam Failure Analysis

The peak outflow that would result from the failure of Upper Ammonoosuc Dam can be estimated using the procedure suggested in the Corps of Engineers, New England Division's April 1978 "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs." Failure is assumed to occur with the water surface level at the dam crest elevation of 892.3 feet NGVD, 4.3 feet above the spillway crest. The discharge just prior to failure at that elevation is given by the Stage-Discharge curve (shown in Appendix D) as 7,900 cfs. The tailwater prior to failure, as established from rating curves for downstream controls, would be about 5.6 feet above its normal level, or at an elevation of 885.9 feet. This is 2.1 feet below the spillway level.

For an assumed breach width equal to about 40% of the dam width at the half-height, the gap in the dam due to failure would be 100 feet. If this gap were to occur in the spillway section of the dam, it would affect about two thirds of the spillway length. It is assumed that the breach would extend to the streambed and would include both the fixed flashboards and the underlying timber crib permanent section. The resulting increase in flow would be 9,700 cfs. The total failure flow, including the prefailure flow of 7,900 cfs, would therefore be 17,600 cfs.

The first downstream reach spans about 2,500 feet between the dam and a railroad bridge. This reach is characterized by banks 4 feet to 8 feet high, with broad flat overbank sections. All development in this reach is high enough to escape damage in the event of dam failure. The high bridge embankment would act as a constriction to diminish any failure wave but would not itself be expected to be damaged. The constriction at the railroad embankment opening would reduce the dam break discharge to about 16,100 cfs.

The downstream flow hazard area most susceptible to damage due to dam failure is the residential and industrial development located in the vicinity of the Brookland Dam, about 4,500 feet downstream. This development consists of four houses in the left overbank area just upstream of the dam and six to eight more houses on the same side along the road adjacent to the dam. This region would act as an overflow section to the dam at stages higher than 3 feet above normal (i.e., above the Brookland Dam Spillway elevation). The living areas of all these houses are about 4 feet above the normal pool level. On the right bank in this same area is a large paper processing plant, consisting of many individual structures. Several of these are located at elevations equal to or less than that of the Brookland Dam spillway. A dike about 3 feet high prevents flows from inundating the plant.

Storage between the railroad crossing and the Brookland Dam would further reduce the dam break discharge to about 15,100 cfs. This flow would increase the prefailure stage of 5.5 feet to 7.3 feet. Prefailure flooding conditions for a flow of 7,900 cfs would produce minor flooding of about one foot in depth in the houses along the left bank, and significant overtopping of the right bank dike into the paper plant complex. The failure wave would suddenly increase the depth of flooding in the residential area from about 1 foot to 3 feet and would greatly increase the flow through the paper plant. The additional property damage and loss-of-life potential due to failure would be significant.

Downstream of the 20-foot drop through the Brookland Dam, the river is confined within the high banks of the channelized section of river. Flows overtopping and passing around the ends of the dam would return to the channel and would not be expected to cause significant damage elsewhere in Groveton. Having passed through this channelized reach, the flood plain of the Upper Ammonoosuc River merges with the very broad, flat flood plain of the Connecticut River. This area would rapidly diminish the dam failure flows, and no further hazard would be expected downstream of that described in the vicinity of Brookland Dam.

The appropriate hazard classification for this dam is HIGH because of the significant economic losses and potential for loss of more than a few lives downstream in the event of failure of the dam. As shown in the Dam Failure Analysis section, the

increase in flooding caused by failure would result in property damage and the potential for lost lives at ten to twelve houses and at a paper plant in the vicinity of Brookland Dam about one mile downstream.

The downstream impacts of the failure of Upper Ammonoosuc Dam are summarized on the chart on the following page. Due to the potential for loss of more than a few lives in the event of a dam failure, the appropriate hazard classification for this dam is HIGH.

IMPACTS OF DAM FAILURE

Location	Distance D/S of Dam (ft.)	Number of Dwellings	Level Above Normal (ft.)	Flow and Stage		Comments
				Before Failure	After Failure	
Railroad Bridge	2500	-	7	7900 cfs 5.6 feet	16100 cfs 7.6 feet	Little damage to Railroad Structure
Houses U/S of Brookland Dam	4000	4	4	7900 cfs 5.5 feet	15100 cfs 7.3 feet	Severe flooding - possible loss of life
Brookland Dam	4500	6-8	4	7900 cfs	15100 cfs	Severe flooding to residences and paper plant - high property damage and loss of life potential
D/S of Brookland Dam	4500-13000	-	-	-	-	Little damage potential in dam failure wave zone

Section 6: Structural Stability

6.1 Evaluation of Structural Stability

(a) Visual Observations

The Upper Ammonoosuc Dam is in fair condition at the present time. Evaluation of the decay of the left abutment is recommended. No other structural deficiencies were noted which warrant further investigation.

(b) Design and Construction Records

No plans or calculations of value to a stability assessment are available for this dam.

6.2 Design and Construction Data

No records of structural stability analyses are available for this dam.

6.3 Post Construction Changes

The dam was constructed in about 1920. The dam was repaired in 1972, which repair included the installation of four new metal sluice gates and bench stands at the right abutment.

6.4 Seismic Stability

The dam is located in seismic zone No. 2 and, in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

Section 7: Assessment, Recommendations, and Remedial Measures

7.1 Dam Assessment

(a) Condition

The Upper Ammonoosuc Dam is in fair condition at the present time.

(b) Adequacy of Information

The lack of in-depth engineering data precludes a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Urgency

The engineering studies and improvements described herein should be implemented by the owner within one year of receipt of this Phase 1 Inspection Report.

7.2 Recommendations

It is recommended that the services of a qualified registered professional engineer be retained to:

(a) Conduct a detailed hydraulic and hydrologic study to further define the need for and means to increase the project discharge capacity and the ability of the dam to withstand overtopping.

(b) Evaluate the condition of the timber crib and earthfill at the left abutment and prepare plans for its restoration.

(c) Conduct a detailed inspection of the spillway under low flow conditions.

The owner should implement the findings of the above engineering studies.

7.3 Remedial Measures

It is recommended that the following remedial measures be undertaken by the owner:

(a) Implement a program of annual technical inspections of the dam and its appurtenances, including operation of all outlet works.

(b) Develop a plan for surveillance of the dam during flood periods and a formal emergency system for warning the downstream residents and the appropriate officials.

(c) Implement and intensify a program of diligent and periodic maintenance, including immediate removal of debris from the left sluiceway.

7.4 Alternatives

There are no meaningful alternatives to the above recommendations.

APPENDIX A

VISUAL CHECKLIST WITH COMMENTS

Inspection Team Organization

DATE: May 14, 1981

PROJECT: NH00370
Upper Ammonoosuc Dam
Northumberland, New Hampshire
NHWRB No. 182.04

WEATHER: Cloudy, cool

INSPECTION TEAM:

Nicholas A. Campagna	Goldberg-Zoino & Assoc.	Team Captain
William S. Zoino	GZA	Soils
Jeffrey M. Hardin	GZA	Soils
Paul Razgha	Andrew Christo Engineers	Structures
Carl Razgha	ACE	Structures
Richard Laramie	Camp Dresser & McKee	Hydraulics

NHWRB Representative Present - Mr. Richard Debold

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
DAM EMBANKMENT		
Crest Elevation	NAC	892.3 feet NGVD
Current Pool Elevation		888.0 feet
Maximum Impoundment to Date		No data
Surface Cracks		None
Pavement Condition		Not applicable
Movement or Settlement of Crest		None noted
Lateral Movement		None noted
Vertical Alignment		Good
Horizontal Alignment		Good
Condition at Abutment and at Concrete Structures		Sink holes in left abutment due to missing timber sheeting.
Indications of Movement of Structural Items on Slopes		None noted
Trespassing on Slopes		None
Vegetation on Slopes		None
Sloughing or Erosion of Slopes or Abutments	NAC	Sink holes in left abutment and erosi of abutment contact.

CHECKLIST FOR VISUAL INSPECTION

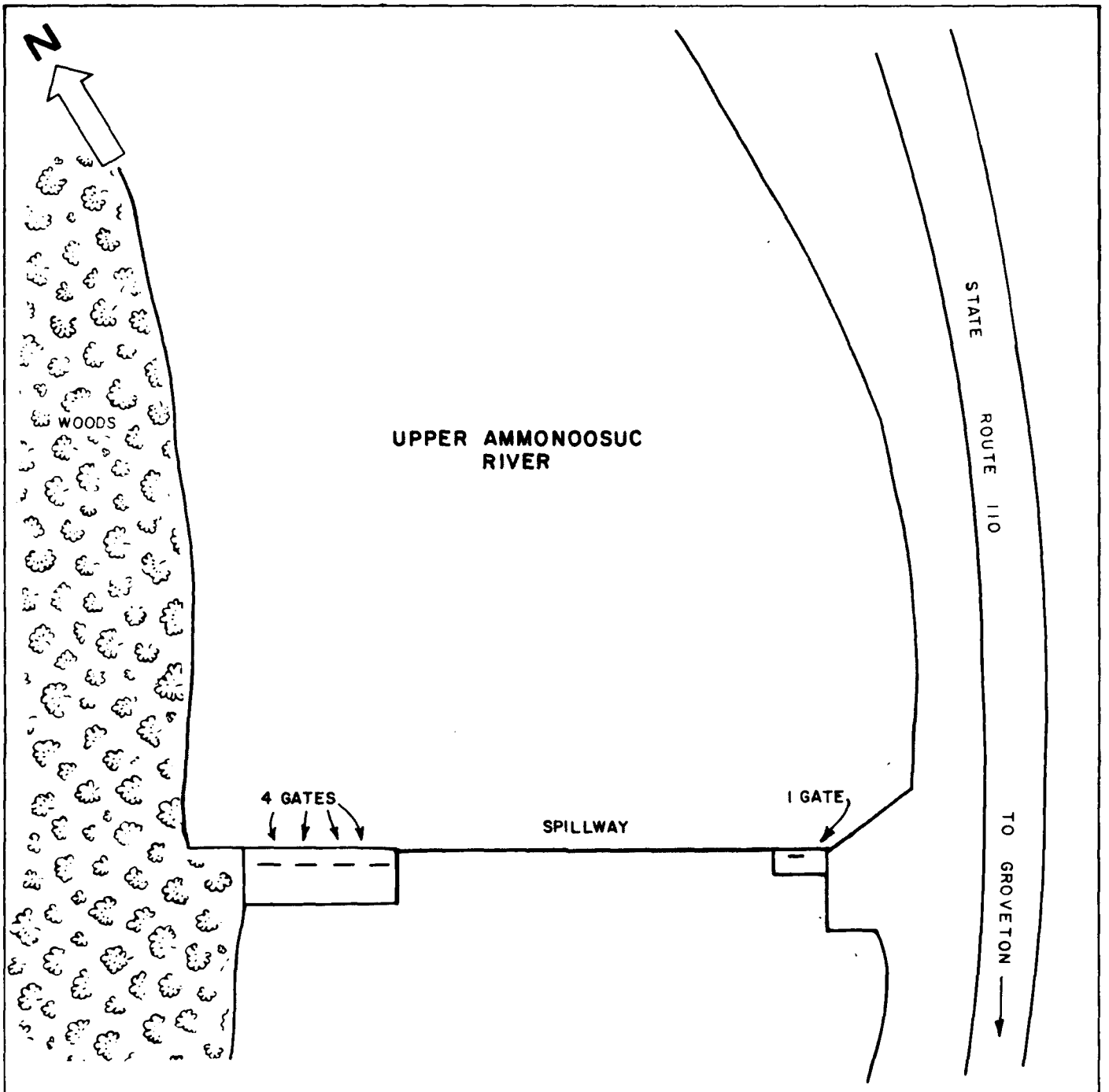
AREA EVALUATED	BY	CONDITIONS AND REMARKS
Rock Slope Protection - Riprap Failures	NAC	None
Unusual Movement or Cracking at or near Toes		None
Unusual Embankment or Downstream Seepage		None
Piping or Boils		None
Foundation Drainage Features		None
Toe Drains		None
Instrumentation System	NAC	None
LEFT ABUTMENT	PR	
Timber Crib		Partially rotted, vertical planting missing. Seepage adjacent to spillway.
SPILLWAY		Good
RIGHT ABUTMENT		Good
WASTE GATE - LEFT ABUTMENT		
Gate		Good
Operating Mechanism		Good
WASTE GATE - RIGHT ABUTMENT		
Gate		Good
Operating Mechanism	PR	Good

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
RESERVOIR		
Slopes	NAC	Generally shallow to moderate slopes, highway along left bank, generally stable.

APPENDIX B

ENGINEERING DATA



GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

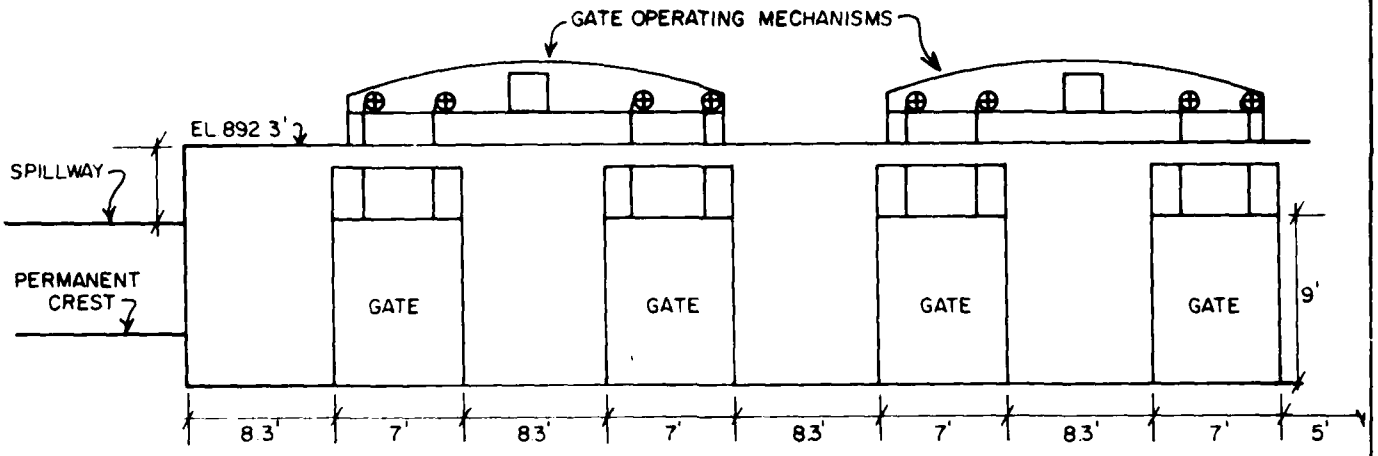
SITE PLAN

FILE No 2605

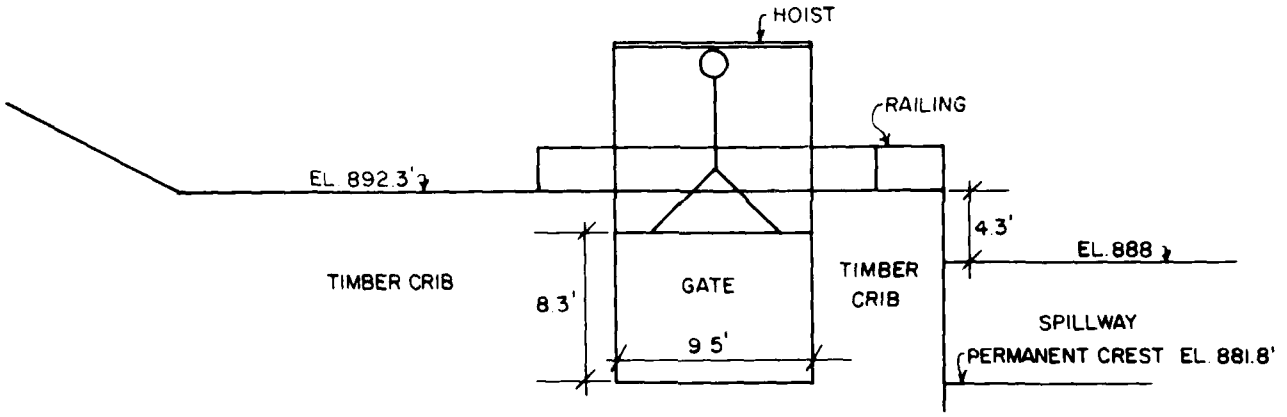
UPPER AMMONOOSUC DAM NORTHUMBERLAND, NH.

SCALE 1" 60'

DATE JUNE 1981



RIGHT GATE STRUCTURE



LEFT GATE STRUCTURE

GOLDBERG ZOINO & ASSOCIATES, INC GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS NEWTON UPPER FALLS, MASSACHUSETTS	US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

CROSS SECTIONS

FILE No 2605

UPPER AMMONOOSUC DAM — NORTHUMBERLAND, N.H.

SCALE NOT TO SCALE

DATE JUNE 1981

NEW HAMPSHIRE WATER RESOURCES BOARD
U. S. CORPS OF ENGINEERS
INVENTORY OF DAMS

Film Roll No. 11-1
Picture Seq. 24

SITE EVALUATION DATA

Quad. Guildhall

ID No. 5

NH No. 182.04 DA= 247 sq. mi. Inspection Date 7/28/80 By F. Moore

COE No. 370 Town Northumberland

NAME OF IMPOUNDMENT UPPER AMMONOOSUC Dam

POPULAR NAME Red Dam or Upper Dam

OWNER(S) Groveton Papers Co.

ADDRESS Groveton, NH. 03

ZIP CODE:

RIVER OR STREAM Upper Ammonoosuc River

EXISTING DOWNSTREAM DEVELOPMENT 2 Dams within 2 miles and
Extensive housing, roads, bridges & RR

DOWNSTREAM HAZARD: 3 = Low 2 = Significant (1 = High) NO Hazard

TYPE OF DAM: Earth, Rockfill, Gravity, Buttress, Arch, Timber Crib

Other owner should be notified that fill near right side near left abutment is eroded. Should refill and repair timber

PURPOSE: Irr., Hydro., Fld. Control, Water Supply, Rec., Wildlife Mgt. Etc.

Other Storage for release to maintain level in two dam downstream

HEIGHT: Structural 15 Hydraulic 15

POND SIZE (acres) 50± AVERAGE DEPTH (feet) 6 300 to 450 Ac. Storage

DAM CREST LENGTH (bank to bank) 375'

SPILLWAY: Controlled, Uncontrolled, None WIDTH 208' Present FREEBOARD 3.9'

OUTLET WORKS 5 Gates - 7'wd

REMARKS Top of 3' flashboards are 4' below top of dam.
#36 View of spillway from left abutment (showing side flood gate
#37 " " impoundment and log boom against dam
#1 " tail water - actually portage from dam # 182.03
#2 from left abutment of dam. (Brookland dam)
→ From upstream right side of 4 gate Section looking
and spillway.

N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: Northumberland Dam Number: 182.04

Inspected by: Robert B. Chamberlin Date: Oct. 27 19 72

Local name of dam or water body: _____

Owner: Groveton Paper Co. Address: Groveton, N.H.

Owner was/was not interviewed during inspection.

Drainage Area: 247 sq. mi. Stream: Upper Ammonoosuc River

Pond Area: 75± Acre, Storage +75 surface 75 Normal Ac-Ft. Max. Head 7 Ft.

Foundation: Type _____, Seepage present at toe - Yes/No, _____

Spillway: Type Log crib, Freeboard over perm. crest: 7',

Width 200±, Flashboard height 3',

Max. Capacity _____ c.f.s.

Embankment: Type _____, Cover _____ Width _____,

Upstream slope _____ to 1; Downstream slope _____ to 1

Abutments: Type Crib, Condition: Good, Fair, Poor

Gates or Pond Drain: Size 5 - 7' wide Capacity _____ Type Lift gates

Lifting apparatus 2 racks per gate - pinion Operational condition Good

Changes since construction or last inspection: Four gates installed in right abutment, one in left. Gate 7' wide made of 1" steel plate. Abutment and sluiceways sheathed with steel plate.

Downstream development: 182.03

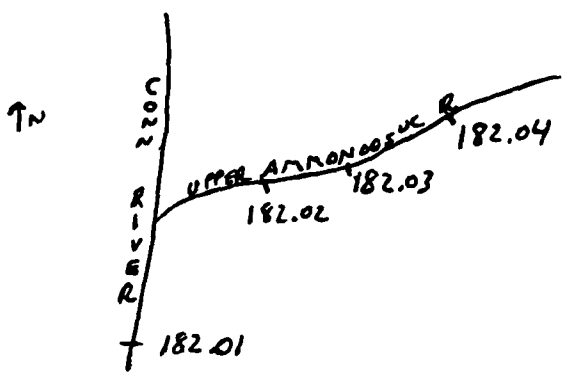
This dam would/would not be a menace if it failed.

Suggested reinspection date: _____

Remarks: Flash boards and supports neatly stored for winter. All railings and gate metalwork newly painted, permanent crest in good condition.

31 — 182.04

GROVETON PAPER STILL OWNS THIS DAM, KNOWN AS THE RED DAM OR UPPER DAM. IT'S USED AS STORAGE TO MAINTAIN HEAD ON 182.03 (BROOKLAND DAM"), WHICH SUPPLIES PROCESS WATER TO MILL. GROVETON PAPER ALSO OWNS 182.02, KNOWN AS THE LOWER DAM (ONCE USED FOR POWER, AS WAS 182.03), AND 182.01 ON THE CONN R.



DWB

OK

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 182.04

Town Northumberland: County Coos

Stream Upper Ammonoosuc River

Basin-Primary Connecticut: Secondary Upper Ammonoosuc

Local Name

Coordinates—Lat. 44° 35' + 12800: Long. 71° 30' + 2500

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 247 Sq. Mi. AE

Overall length of dam 375 ft.: Date of Construction

Height: Stream bed to highest elev. 15 ft.: Max. Structure 8 ft.

Cost—Dam: Reservoir

DESCRIPTION Crib logs timber and stone Foundation earth

Waste Gates

Type

Number: Size ft. high x ft. wide

Elevation Invert: Total Area sq. ft.

Hoist

Waste Gates Conduit

Number: Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width: Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway: Left of Spillway

Spillway

Materials of Construction

Length—Total 200 ft.: Net ft.

Height of permanent section—Max. 2 ft.: Min. ft.

Flashboards—Type Fixed 3' : Height ft.

Elevation—Permanent Crest: Top of Flashboard

Flood Capacity 13800 cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 2' ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Groveton Paper Co.

REMARKS Maintenance yes Condition fair

Subject to inspection

Tabulation By [illegible] Date April 58

B&B21284

Co.

No. 182.

CALCULATION SHEET

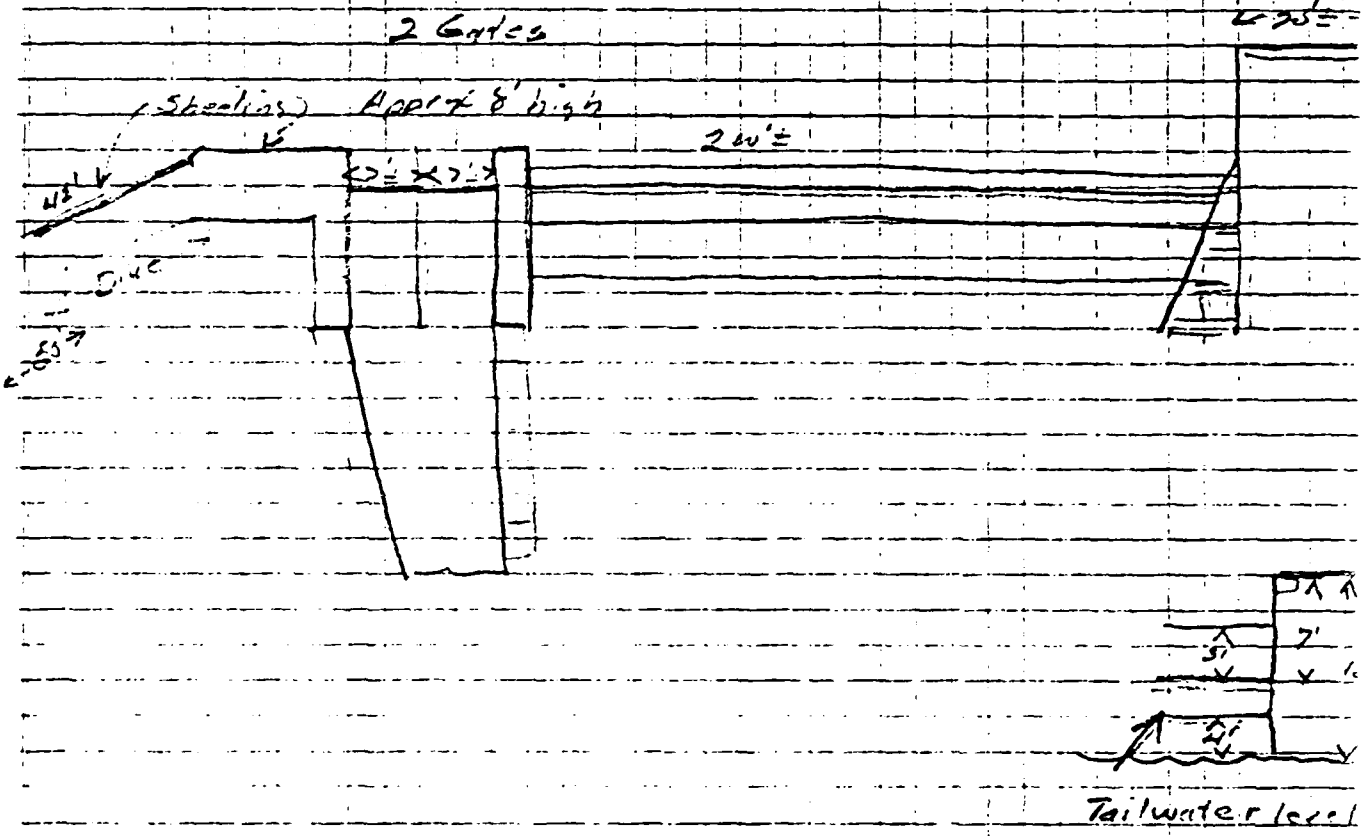
Date Aug. 10, 1936

Refers to

Made By ACB

3046

Northumberland Ft



NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Connecticut NO. 4 — — I-5428
RIVER Upper Ammonoosuc MILES FROM MOUTH 3.7 D.A.SQ.MI. 247 AE
TOWN Northumberland OWNER Groveton Paper Co., Groveton
LOCAL NAME OF DAM
BUILT _____ DESCRIPTION Crib — Logs, Timber & Stone on Earth

POND AREA-ACRES _____ DRAWDOWN FT. _____ POND CAPACITY-ACRE FT. _____
HEIGHT-TOP TO BED OF STREAM-FT. 15± 3/6 MAX. _____ MIN. _____
OVERALL LENGTH OF DAM-FT. 300± MAX. FLOOD HEIGHT ABOVE CREST-FT. _____
PERMANENT CREST ELEV. U.S.G.S. 881.8 AE LOCAL GAGE _____
TAILWATER ELEV. U.S.G.S. _____ LOCAL GAGE _____
SPILLWAY LENGTHS-FT. 200 ± FREEBOARD-FT. 7
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST 3' Fixed 6.1 AE
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST
— — — —
— — — —
— — — —

REMARKS Condition Fair
5C Into Connecticut R.

POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

USE Conservation Logging

REMARKS Inactive

DATE 8/1/34

Form EIA
4845

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5428

TOWN	NORTHUMBERLAND	TOWN NO. 4	STATE NO. 182.04
RIVER STREAM	Upper Amonoosuc River		
DRAINAGE AREA		POND AREA	
DAM TYPE	Crib	FOUNDATION NATURE OF	Earth
MATERIALS OF CONSTRUCTION	Logs, Timber, Stone		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	Approx. 15'	TOP OF DAM TO SPILLWAY CRESTS	7'
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	Approx. 200'	LENGTH OF DAM	Approx. 3
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	Fixed 3'		
OPERATING HEAD CREST TO N. T. W.		TOP OF FLASHBOARDS TO N. T. W.	
WHEELS, NUMBER KINDS & H. P.			
GENERATORS, NUMBER KINDS & K. W.			
H. P. 90 P. C. TIME 100 P. C. EFF.		H. P. 75 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS			

REMARKS

OWNER: Groveton Paper Co.

CONDITION: Fair

MENACE: Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made Aug. 10, 1936, according to notification to owner dated Aug. 5, 1936, and bill for same is enclosed.

D. Waldo White
Chief Engineer

Aug. 19, 1936
Copy to Owner

NEW HAMPSHIRE WATER RESOURCES BOARD
U. S. CORPS OF ENGINEERS
INVENTORY OF DAMS

Film Roll No. 3

Picture Seq. 15-22

SITE EVALUATION DATA

Quad. Monadnock

ID No. 79

NH No. 20603 Inspection Date May 5, 1980 By C E Hale

COE No. 398 Town Roxbury

NAME OF IMPOUNDMENT Pebble Lodge Pond

POPULAR NAME

OWNER(S) Keene

ADDRESS

ZIP CODE:

RIVER OR STREAM Otter Brook Tributary

EXISTING DOWNSTREAM DEVELOPMENT

DOWNSTREAM HAZARD: 3 = Low (2) = Significant 1 = High NO Hazard

TYPE OF DAM: Earth, Rockfill, Gravity, Buttress, Arch, Timber Crib

Other with concrete step log section

PURPOSE: Irr., Hydro., Fld. Control, Water Supply, Rec., Wildlife Mgt.

Other 3:1 upstr. slope 2:1 downstr.

HEIGHT: Structural 20' Hydraulic 28'

POND SIZE (acres) 10 acres = 30 AVERAGE DEPTH (feet) 15'

DAM CREST LENGTH (bank to bank) 255'

SPILLWAY: Controlled, Uncontrolled, None WIDTH 39' FREEBOARD 5.9'

OUTLET WORKS 4 bays 9.2' long 5.9' high step log section, 3.4' of step log at present

REMARKS

spillway section - top of steplog section to base of structure on ledge is 13.9'

D.A. 5.5 sq mi.

CITY OF KEENE

NEW HAMPSHIRE 03431

January 13, 1977

RECEIVED
G.M.M. Sr.
JAN 17 1977
NEW HAMPSHIRE
WATER RESOURCES BOARD

Mr. George M. McGee, Sr.
State of New Hampshire
Water Resources Board
Concord, New Hampshire 03301

Dear Mr. McGee:

This letter is in reference to your letter dated December 20, 1976 pertaining to to (Dam #206.01 and Dam #206.03) and letter dated January 5, 1977 pertaining to (Dam #126.03).

As of this date, all work done has been completed as per your request on Dam #206.03.

The work on Dam #206.01 will be started in May 1977 when the snow has gone and spring conditions permit vehicles being able to get to this dam.

This work should be accomplished within two (2) weeks from the starting date.

Dam #126.03, the work will start during the week of January 17th and should be completed by February 1, 1977.

Very truly yours,

George M. Gline

GEORGE M. GLINE
DIRECTOR OF PUBLIC WORKS

GMG:eam

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

Town: Roxbury Dam Number: 206.03

Name of Dam, Stream and/or Water Body: Babbage Res

Owner: Keene Water Works Telephone Number:

Mailing Address:

Max. Height of Dam: 16' Pond Area: 32 Length of Dam: 215'

FOUNDATION: Hardpan & Ledge

OUTLET WORKS: 4 - 9' Stoplog sections water about 3' above crest
16" & 12" Water System Intake pipe
20" waste pipe

ABUTMENTS:

EMBANKMENT: Earth Embankment 2½ To 1 upstream with Riprap 2:1 downstream With many Trees

Note: Give Sizing, Condition and detailed description for each item, if applicable.

SPILLWAY: Length: 4 @ 9' Freeboard: Total 6'

SEEPAGE: Location, estimated quantity, etc.

Changes Since Construction or Last Inspection:

Tail Water Conditions:

Overall Condition of Dam: Good

Contact With Owner:

Date of Inspection: 30 Nov 76 Suggested Reinspection Date

Class of Dam:

Signature

Date

Note: Give Sizing, Condition and detailed description for each item, if applicable.

State of New Hampshire

WATER RESOURCES BOARD

CONCORD 03301

Dec. 20, 1976

Director,
Keene Water Works
Keene, N. H 03431

Dear Sir:

Under the provisions of RSA 482, Section 8 thru 15, on Nov. 30, 1976, an engineer of the Water Resources Board staff inspected four dams in the Town of Roxbury owned by the Keene Water Works. These dams, on Woodward Pond (Dam #206.01)and on Babbage Reservoir (Dam #206.03) are classifed in the files of this office as menace structures and as such must be maintained in a manner not to endanger public safety nor become a dam in disrepair.

As a result of this inspection it was noted that several items of maintenance or repairs in need of attention.

Woodward Pond (Dam #206.01)

1. The west abutment wall at the overflow spillway is cracked and is tipping into the spillway. This is to be repaired to prevent water from washing around the spillway

2. There is a small area to the West of the outlet pipe where water appears to be seeping under or through the embankment. This seepage is to be stopped to prevent the possible undermining and washout of the embankment.

Babbage Reservoir (Dam #206.03)

1. Trees that are on the embankment are to be removed. This is to prevent possible damage by the roots or an entire tree being uprooted.

Because these dams are classified as menace structures we require that you send us a proposed schedule of repairs within thirty days. This is not to say that the work is to be completed or even started within this time but that we would like your anticipated dates that this work will take place.

If we can be of any assistance or you have any questions please contact us at your convenience.

Very truly yours,

George M. McGee, Sr.
Chairman

GMMG:scb:ebs

Rec'd 10/19/38

Jacobson	
Holmgren	✓
[illegible]	
Return to	
Filed	
File No.	

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire

October 13, 1938.

Keene Water Board,
Keene N H

RE: Babbage Rest Dam. W. C. C. No. 08.03

Gentlemen:

In order that we may determine the magnitude and extent of the flood of September 21-24 just passed, we are requesting the various dam owners in the State to supply us with the following information:

1. Was this dam injured? Ans. No

2. If so, to what extent? Ans. —

3. Did all flashboards go out? Ans. 2 - 9" flashboards.

4. What was the maximum height of water over the permanent crest of spillway? Ans. 3'-6"

5. At what day and hour did the maximum flood height reach your dam? Ans. Some time Sept 22nd. Could not get there to really know.

6. Any other interesting information regarding the flood or rain fall may be given on the back of this sheet, or attach sheets.

Will you please return this letter with as much information as you can give us as promptly as possible. A self-addressed envelope is attached hereto.

We thank you for your cooperation.

Very truly yours,

Richard S. Holmgren

Richard S. Holmgren
Chief Engineer

CDC:GMB
Enc.

206.03 Babbage Res.

Condition is good except for slight leaks thru spillway stone spillway. Leaks are not dangerous.

ck.

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 206.03

Town Roxbury : County Cheshire ✓

Stream Babbage Brook

Basin-Primary Connecticut R. : Secondary Ashuelot R

Local Name [illegible]

Coordinates—Lat. : Long.

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 5.5 ✓ Sq. Mi.

Overall length of dam 215 ✓ ft.: Date of Construction 1931 ✓

Height: Stream bed to highest elev. 16 ✓ ft.: Max. Structure 10 ✓ ft.

Cost—Dam : Reservoir

DESCRIPTION Earth fill earth stone and concrete

Waste Gates

Type 1'8" pipe

Number : Size ft. high x ft. wide

Elevation Invert (12') ? : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction

Length—Total 409' each ✓ ft.: Net 36 ft.

Height of permanent section—Max. 11' ft.: Min. ft.

Flashboards—Type 2.75 Removable ✓ : Height 2.75 ✓ ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity 2100 cfs.: 300 cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 6' ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER City of Keene

REMARKS Condition fair water supply

Tabulation By G.S.W. Date

B&B21284

206.03

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Connecticut NO. 206.03 55 dams.
RIVER Babbage Reservoir MILES FROM MOUTH 1.125 D.A.SQ.MI 6.9
TOWN Roxbury OWNER City of Keene
LOCAL NAME OF DAM Babbidge Reservoir
BUILT 1931 DESCRIPTION Stone & Cement
Earthfill riprap upstream concrete spill
+ corewall, Hardpan + ledge foundation
POND AREA-ACRES 10± DRAWDOWN FT. POND CAPACITY-ACRE FT. 40
HEIGHT-TOP TO BED OF STREAM-FT. 16 V.T MAX. MIN.
OVERALL LENGTH OF DAM-FT. 165 MAX.FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV.U.S.G.S. LOCAL GAGE
TAILWATER ELEV.U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 20-[illegible] = 36' FREEBOARD-FT. 6
FLASHBOARDS-TYPE,HEIGHT ABOVE CREST 2.75 removable stoplogs
WASTE GATES-NO. WIDTH MAX.OPENING DEPTH SILL BELOW CREST
— — — 1½

REMARKS [illegible]
3/4 Mi. Otterbk. Asbestos Mill North Roxbury Rt 3.5 mi from Junction Rt 9 & 10

POWER DEVELOPMENT

UNITS NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

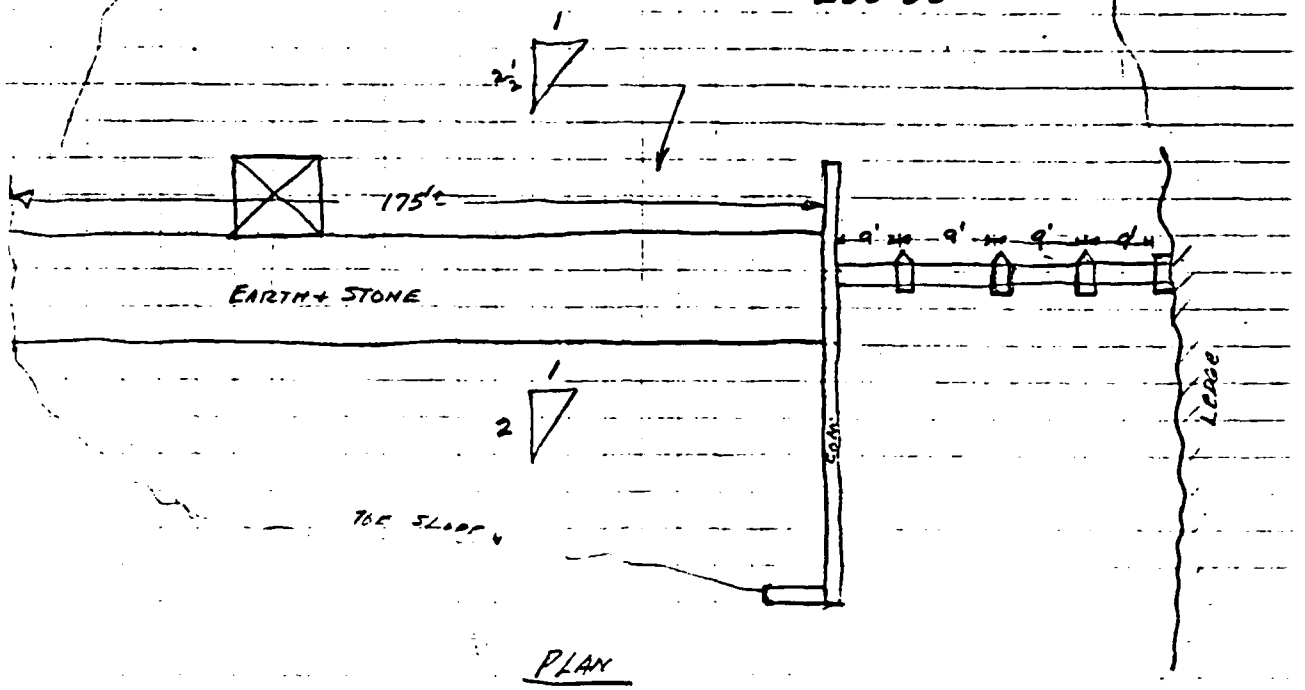
USE Water Supply

REMARKS [illegible] Designed by Weston & Sampson, Boston
[illegible]
Capacity 150,000,000 g.l Col Babbidge Supt.

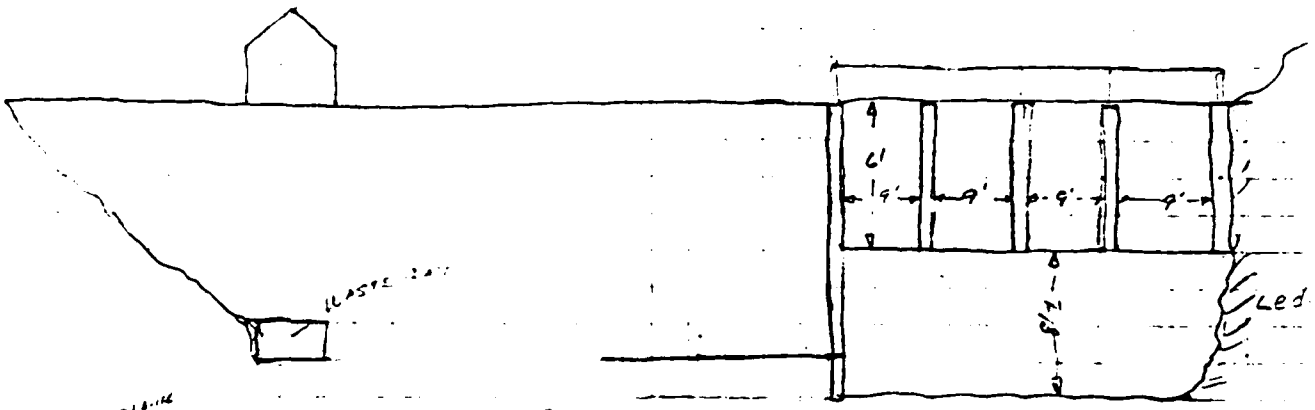
DATE 1935 Pic

BABBIDGE RES. - KEENE WATER SUPPLY 10/6/37

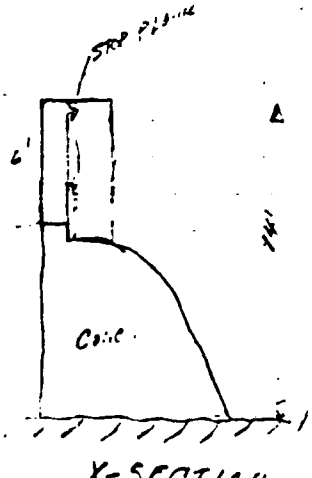
206.03



PLAN



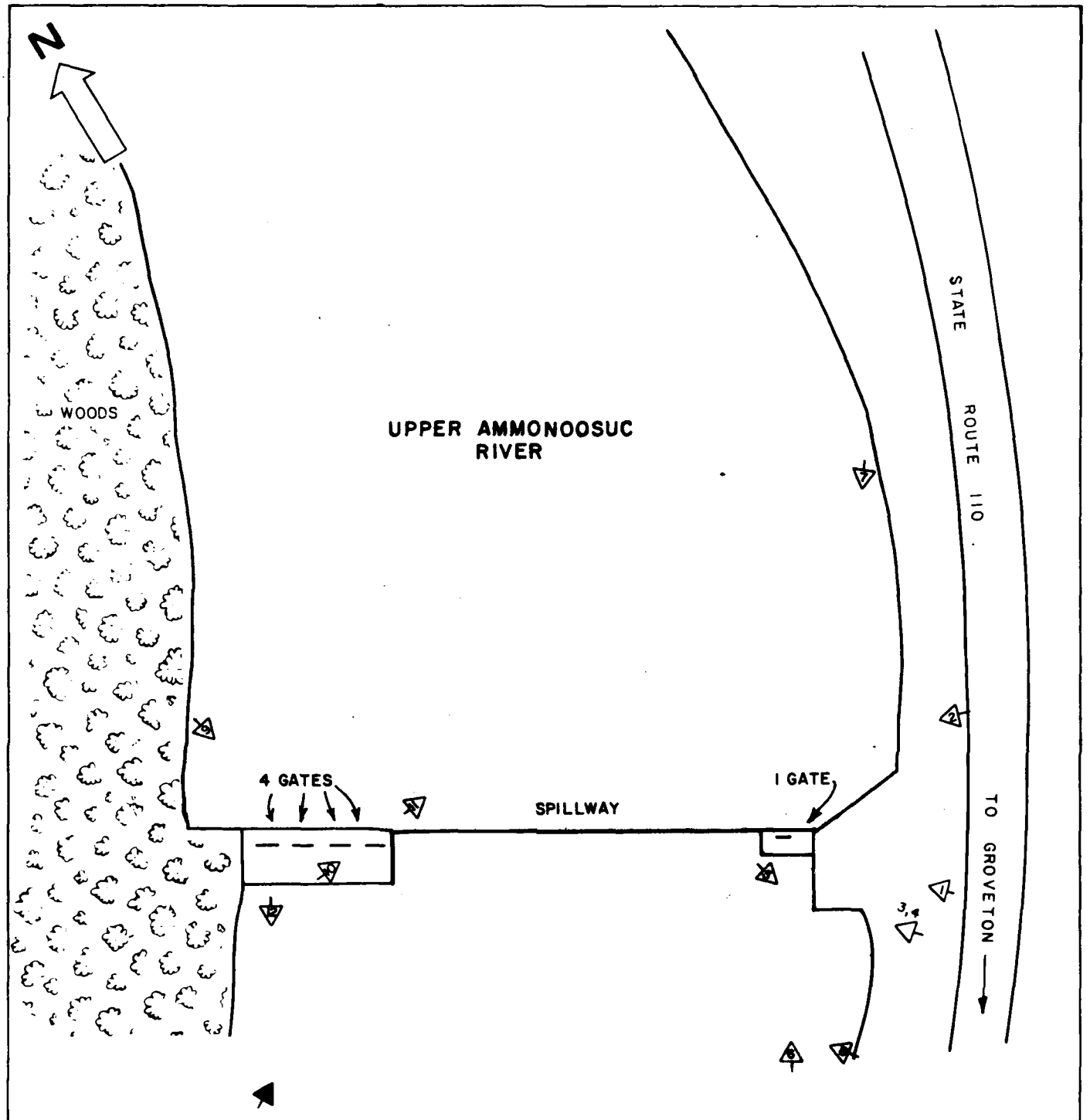
PROFILE



X-SECTION

APPENDIX C

PHOTOGRAPHS



OVERVIEW PHOTO

APPENDIX C PHOTO

GOLDBERG · ZOINO & ASSOCIATES, INC
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

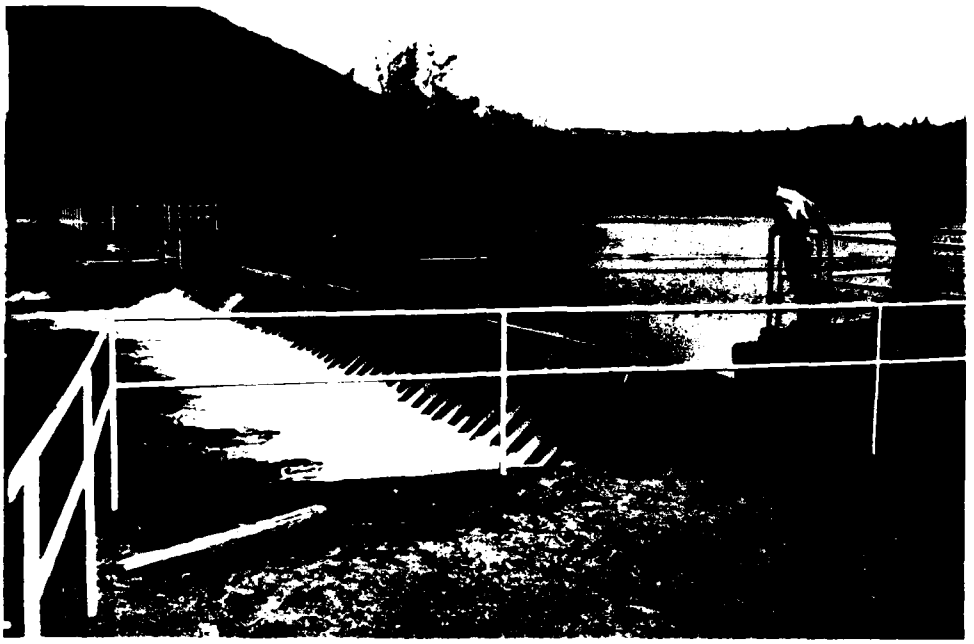
PHOTO LOCATION PLAN

FILE No. 2605

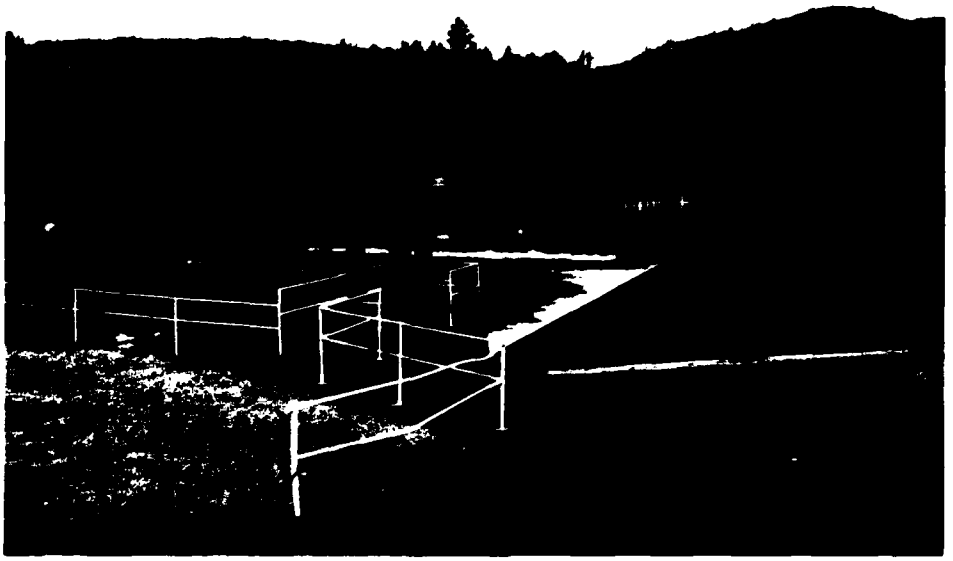
UPPER AMMONOOSUC DAM — NORTHUMBERLAND, NH.

SCALE 1" 60'

DATE JUNE 1981



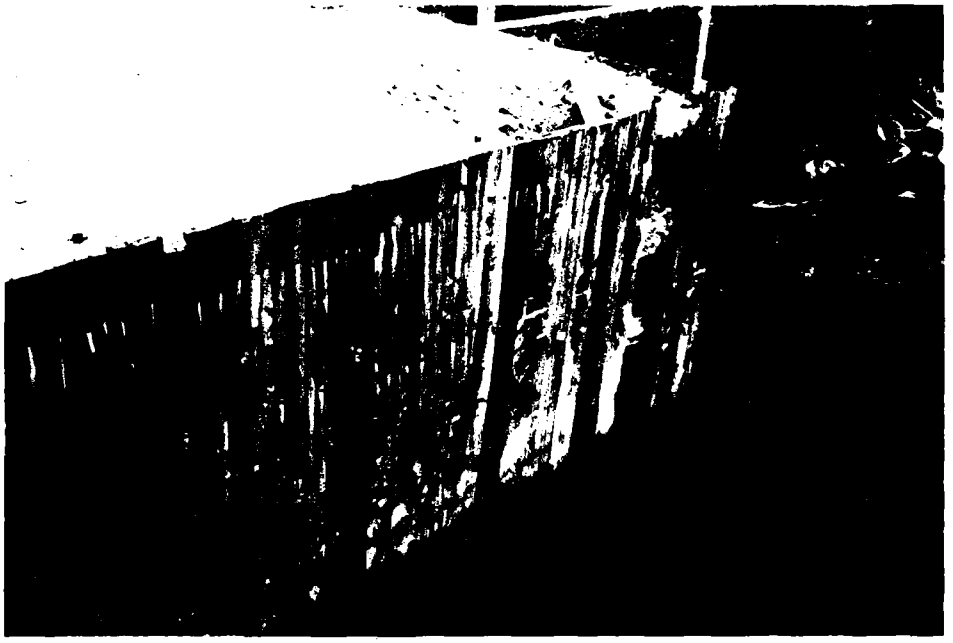
1. Spillway from Left Abutment
   Note: Sink Hole at Lower Left



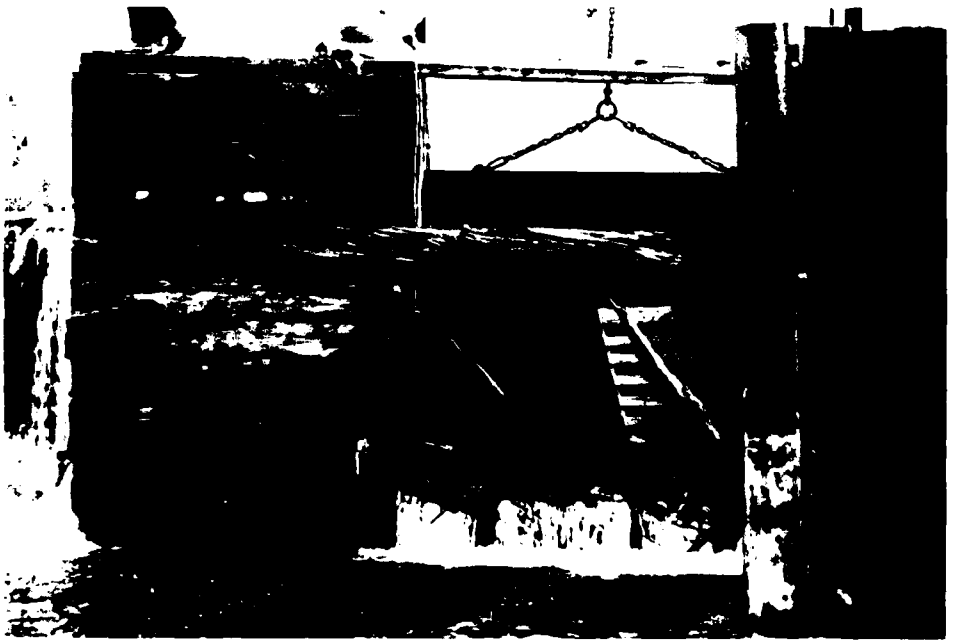
2. Overview from Upstream Left

3. Sheeted Section at Left Abutment
   Note: Sinkholes and Erosion

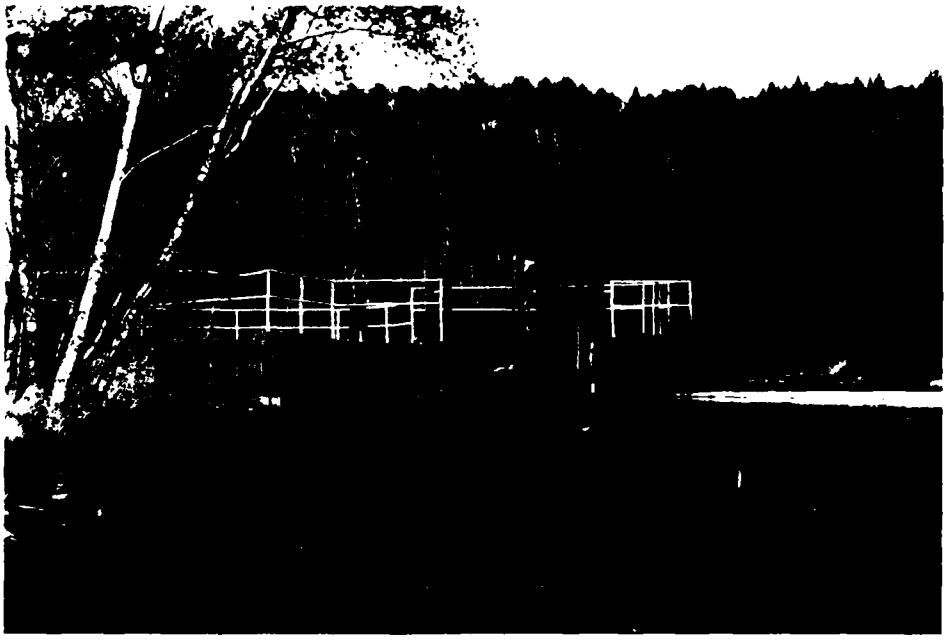
4. Detail of Sinkhole at Left Abutment



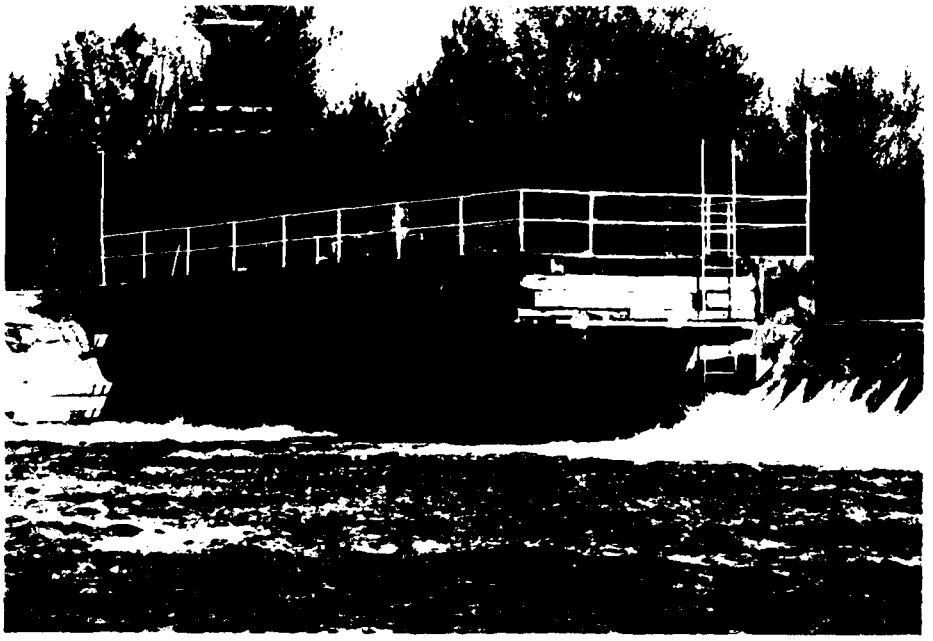
5. Missing Sheeting at Left Abutment



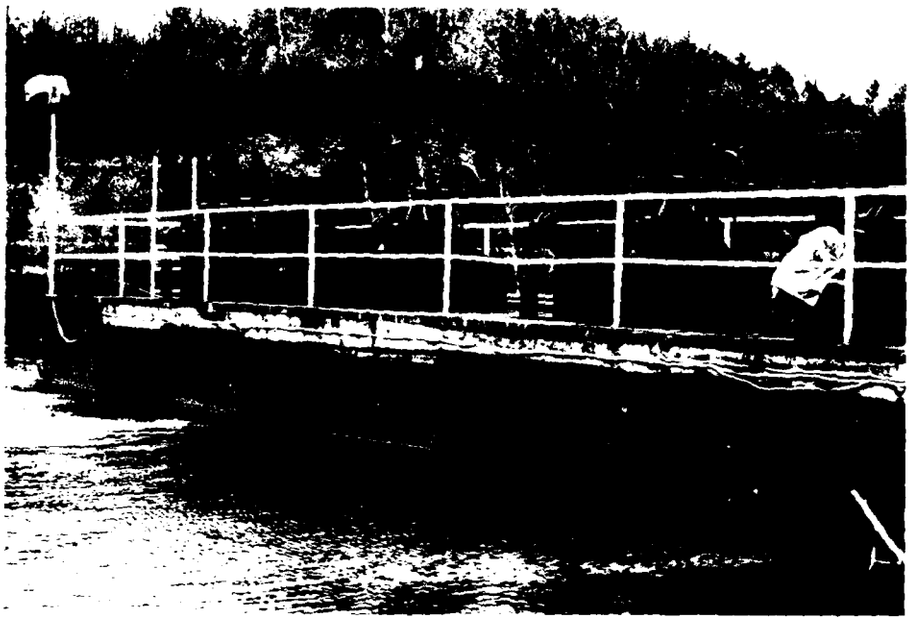
6. Downstream Side of Left Gate Structure
Note: Debris and Missing Sheeting



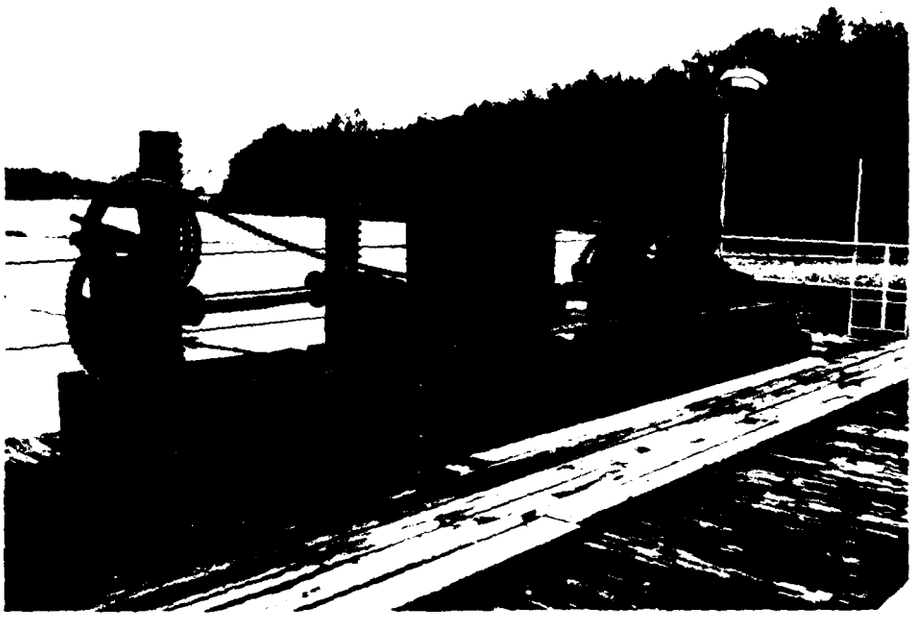
7. Upstream Side of Left Gate Structure



8. Downstream Side of Right Gate Structure



9. Upstream Side of Right Gate Structure



10. Operating Mechanism at Right Gate Structure. Note: Box Houses Electric Motor

11. Upstream Reservoir and Log Boom

12. Downstream Channel

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

Upper Ammonoosic Dam

Stage-Discharge Curve

An elevation sketch of the Upper Ammonoosic Dam is given on the following page based on field measurements and available records.

Calculations of the dam's stage-discharge curve assumes that all gates are operable and are fully open as shown in the sketch. Hydraulic head (h) is measured from the top of the flashboards.

1. Sluice Gates (right end)

   Assume all 4 gates fully open

   $Q_1 = 4[C \times A \times \sqrt{2 \times g \times \text{head}}]$ (Orifice Eq.)

   $C = 0.6$ (Square edge orifice coefficient)

   $A = 7 \times 6 = 42$ sq. ft.

   Head = H + 5.7 ft. (Head on center-line of orifice)

   $Q_1 = 4 \times 0.6 \times 42 \times \sqrt{2g(H + 5.7)}$

2. Wasteway (left end)

   Assume completely open

   $Q_2 = C \times L \times (\text{head})^{1.5}$

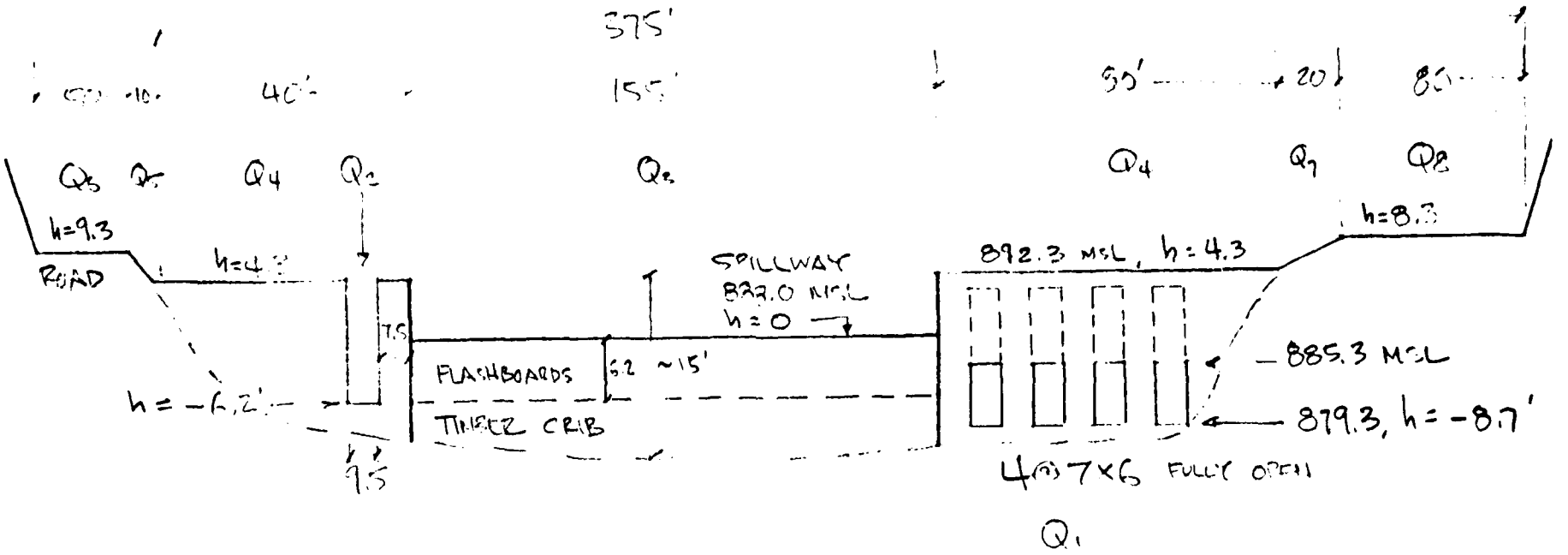
   $C = 3.1$

   $L = 9.5$ ft.

   head = H + 6.2 ft.

   $Q_2 = 3.1 \times 9.5 \times (H + 6.2)^{1.5}$

UPPER AMMONOOSIC DAM



D-3

3. Spillway

$$Q_3 = 3.1 \times 155 \times H^{1.5}$$

4. Dam

$$Q_4 = 3.0 \times (30.5 + 80)\ (H - 4.3)^{1.5}$$

5. Left Abutment

$$Q_5 = 2.8 \times (2\ (H - 4.3))\ (0.5\ (H - 4.3)^{1.5} \quad : \quad H < 9.3$$

$$Q_5 = 2.8 \times 10 \times (H - 6.8)^{1.5} \quad : \quad H \geq 9.3$$

$$Q_6 = 2.8 \times 50 \times (H - 9.3)^{1.5}$$

6. Right Abutment

$$Q_7 = 2.8 \times (5\ (H - 4.3))\ (0.5\ (H - 4.3))^{1.5} \quad : \quad H < 8.3$$

$$Q_7 = 2.8 \times 20 \times (H - 6.3)^{1.5} \quad : \quad H \geq 9.3$$

$$Q_8 = 2.8 \times 80 \times (H - 8.3)^{1.5}$$

The BASIC program used to calculate the head-discharge function is listed on page D-5, followed by tabular results and graphical results.

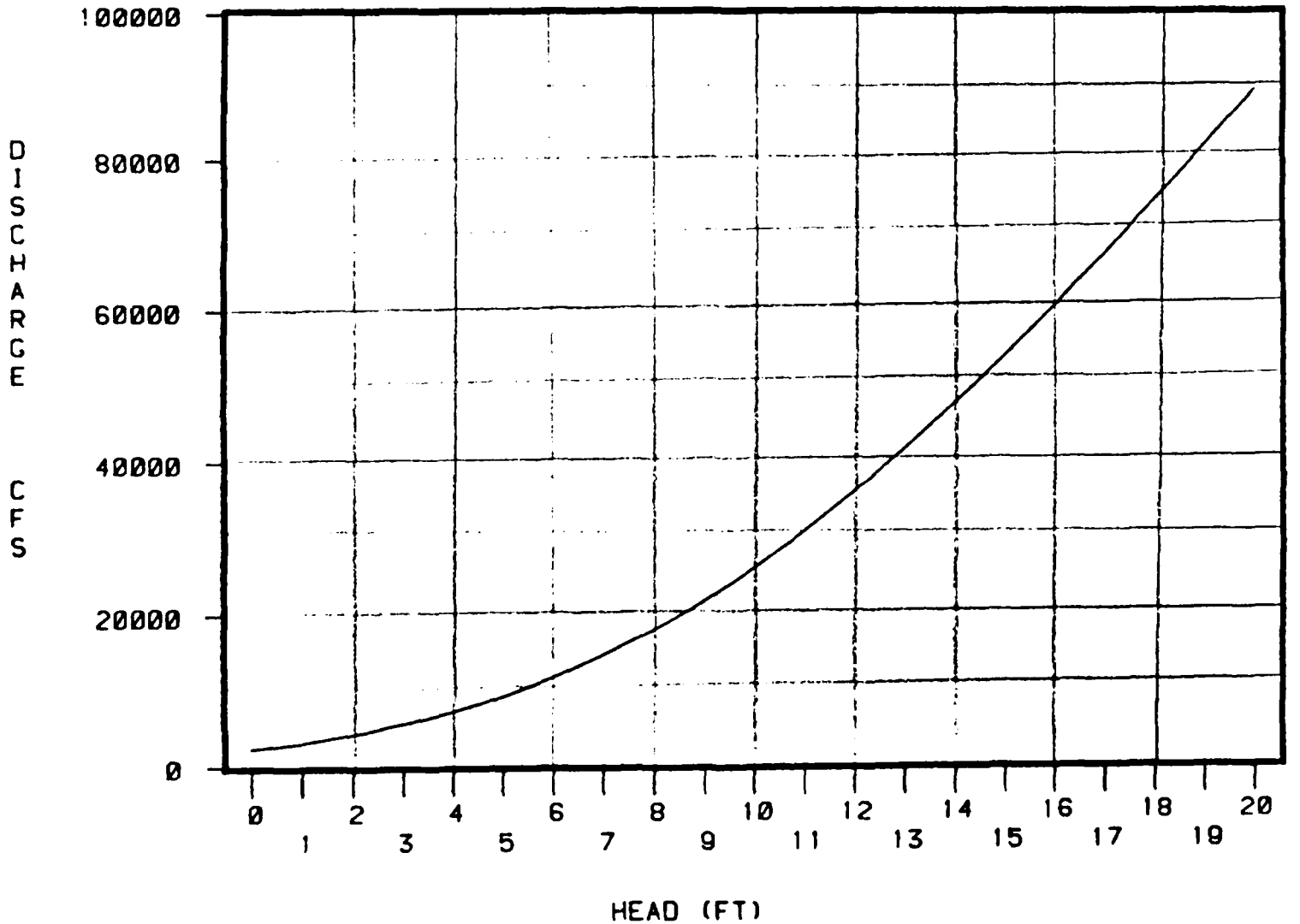
```
100 REMARK: STORED ON TAPE 81, FILE 26
110 PAGE
120 PRINT " HEAD VS. DISCHARGE FOR UPPER AMMONOOSIC DAM"
130 PRINT USING 140:
140 IMAGE /2T"HEAD"30T"DISCHARGE"
150 PRINT USING 160:
160 IMAGE 1T"(FEET)"32T"(CFS)"
170 PRINT USING 180:
180 IMAGE 10T"TOTAL    SLUICE   SPILLWAY    DAM    ABUTMENTS"
190 FOR H=0 TO 20 STEP 1
200 O1=4*0.6*42*(2*32.2*(H+5.7))↑0.5
210 O2=3.1*9.5*(H+6.2)↑1.5
220 O3=3.1*155*H↑1.5
230 O4=0
240 O5=0
250 O6=0
260 O7=0
270 O8=0
280 IF H<=4.3 THEN 370
285 O4=3*(30.5+80)*(H-4.3)↑1.5
290 O5=2.8*(2*(H-4.3))*(0.5*(H-4.3))↑1.5
300 O7=2.8*(5*(H-4.3))*(0.5*(H-4.3))↑1.5
310 IF H<=8.3 THEN 370
320 O7=2.8*20*(H-6.3)↑1.5
330 O8=2.8*80*(H-8.3)↑1.5
340 IF H<=9.3 THEN 370
350 O5=2.8*10*(H-6.8)↑1.5
360 O6=2.8*50*(H-9.3)↑1.5
370 T1=O1+O2
380 T2=O5+O6+O7+O8
390 T3=T1+O3+O4+T2
400 PRINT USING 410:H,T3,T1,O3,O4,T2
410 IMAGE 1T,2D.1D,10D,10D,10D,9D,9D
420 NEXT H
430 END
```

HEAD VS. DISCHARGE FOR UPPER AMMONOOSIC DAM

HEAD (FEET)	DISCHARGE (CFS)				
	TOTAL	SLUICE	SPILLWAY	DAM	ABUTMENTS
0.0	2386	2386	0	0	0
1.0	3143	2663	481	0	0
2.0	4295	2936	1359	0	0
3.0	5705	3208	2497	0	0
4.0	7323	3479	3844	0	0
5.0	9319	3750	5372	194	3
6.0	11845	4022	7062	735	26
7.0	14748	4295	8899	1471	83
8.0	17984	4570	10872	2359	182
9.0	21672	4847	12974	3378	474
10.0	25969	5125	15195	4511	1137
11.0	30801	5406	17530	5749	2116
12.0	36056	5690	19974	7083	3309
13.0	41687	5976	22522	8507	4682
14.0	47661	6264	25170	10015	6212
15.0	53957	6555	27915	11603	7884
16.0	60555	6849	30752	13267	9687
17.0	67440	7145	33680	15003	11612
18.0	74599	7444	36695	16810	13650
19.0	82021	7746	39795	18684	15797
20.0	89697	8050	42977	20622	18047

ASSUMES ALL SLUICE GATES FULLY OPEN

RATING CURVE FOR UPPER AMMONOOSIC DAM



Stage-Storage Curve

The volume of storage in the reservoir with the water level at the spillway crest may be determined from the estimated surface area of 75 acres of this level:

$$\text{Storage} = \frac{\text{Depth at Spillway}}{2} \quad \text{(Surface Area)}$$

$$= \left(\frac{15' - 4.3'}{2}\right) \quad (75 \text{ acres})$$

$$= 400 \text{ AF}$$

Surcharge (above spillway) storage can be estimated for any stage (h) above the spillway as 75h, if the effects of any spreading as the pond rises is neglected. Therefore:

$$\text{Total Storage} = 400 + 75h$$

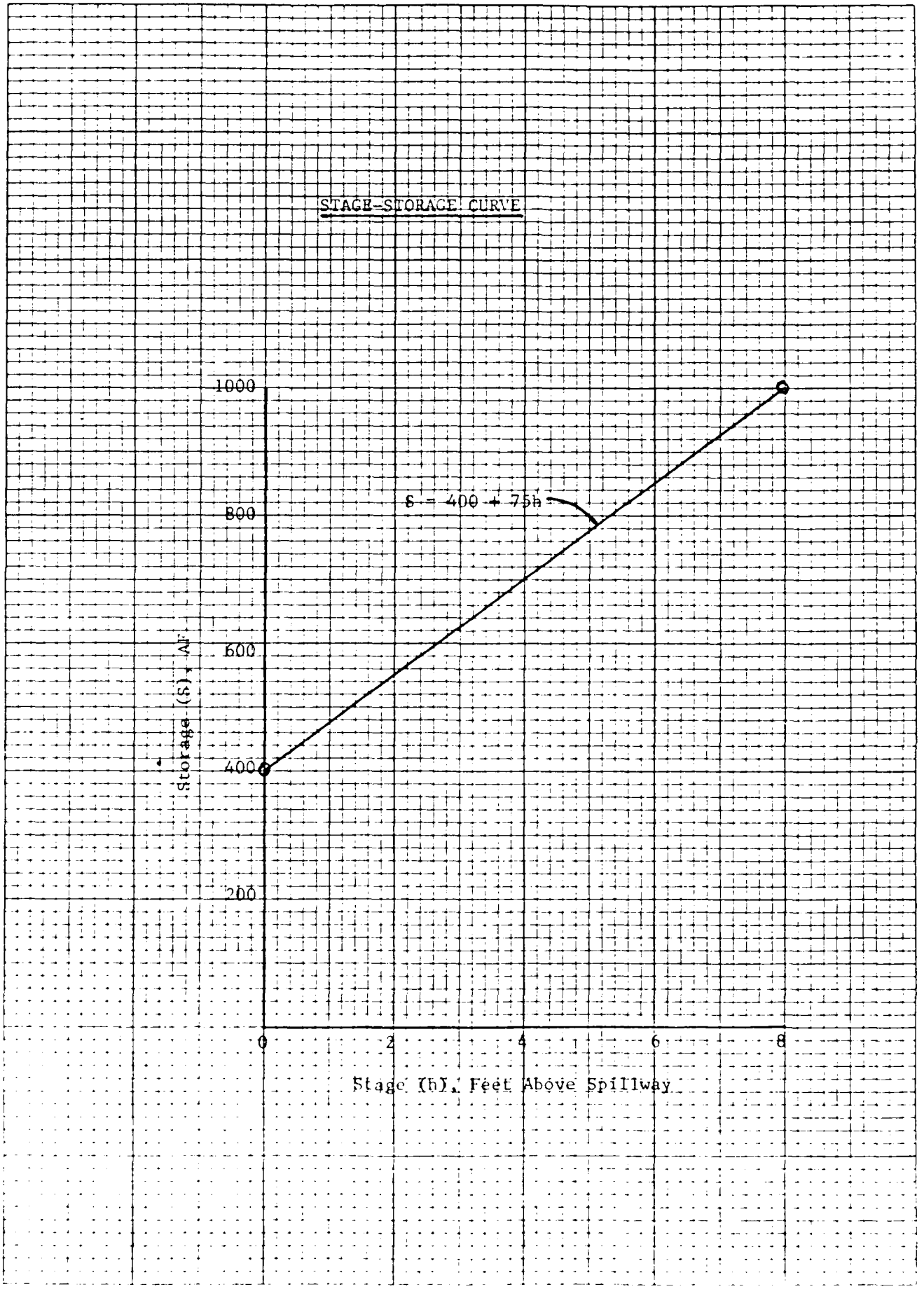
The stage-storage curve for this relationship is given on the next page.

The surcharge storage to the top of the dam is 75(4.3) = 325 AF. It is often convenient to express this quantity in terms of inches of runoff from the contributing drainage area. For the drainage area of 247 sq. miles:

$$1'' \text{ of rainfall} = 247 \times 43560 \times \frac{1}{12} = 896{,}600 \text{ AF}$$

$$\text{Surcharge Storage to top of dam} = \frac{325 \text{ AF}}{896{,}600 \text{ AF/in.}}$$

$$= 0.00036 \text{ inches of runoff}$$


STAGE-STORAGE CURVE
1000
800
600
400
200
S = 400 + 75h
Storage (S), AF
0
2
4
6
8
Stage (h), Feet Above Spillway

Dam Failure Analysis

Assume failure when the dam abutments are overtopped at an elevation of 892.3 feet, 4.3 feet higher than the spillway. From the rating curve:

Pre-Failure outflow = 7900 cfs

This represents a significant flooding situation, and as may be determined from rating curves for downstream controls developed later in this section, would involve overbank flooding in developed areas downstream.

$$\text{Breach Flow} = Q_{pl} = \frac{8}{27} \times Wb \times \sqrt{g} \times (Y_o)^{\frac{3}{2}}$$

Where Wb = breach width

Y_o = breach height

Assume breach occurs in the spillway section and extends to the natural streambed. Use the normal procedure of estimating breach width as 40 percent of the dam width at one-half of its height.

$Wb = 0.4\ (275) = 110$, use

$Wb = 100$ feet

$Y_o = 15$ feet (see elevation sketch)

Therefore:

$$Q_{p1} = \frac{8}{27} (100) \sqrt{32.2} \quad (15)^{1.5}$$

$$= 9770 \text{ cfs}$$

Total Discharge = Pre-failure + Breach

$$= 7900 + 9770$$

$$= 17670 \text{ cfs}$$

A location map showing downstream hazard areas for the Upper Ammonoosic Dam is given at the end of this Appendix. The first downstream reach spans about 2500 feet between the dam and a railroad brid The high bridge embankment acts as a constriction to diminish the failure flow. A sketch of the control section is shown on the next page.

A stage vs. discharge rating curve for this structure may be established as follows:

First Assume Inlet Control

for $H/D < 1.2$

$Q = 2[\frac{2}{3} C_B B H \sqrt{\frac{2}{3} g H}]$ (Henderson, p. 263)

$C_B = 0.9$ (Effect of Side Contraction)

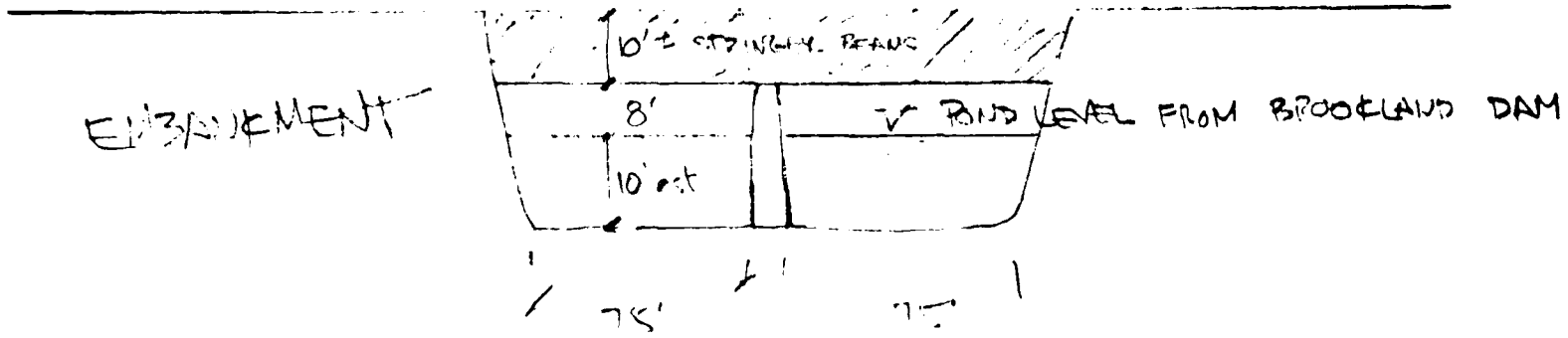
$B = 75$ ft. (Width of Opening)

H = Stage above streambed

$D = 18$ ft. (Height of Opening)

RAILROAD CROSSING

(2500 Feet D/S)



Assume 2 - 75 x 18' Rectangular Openings

$$Q = 2[\frac{2}{3} \times 0.9 \times 75 \times H \sqrt{\frac{2}{3} g H}\ ] = 417.3\ H^{1.5}$$

for $H/D \geq 1.2$

$$Q = 2[C_h \times B \times D \sqrt{2g(H - C_h D)}$$ (Henderson, p. 263)

$C_h = 0.6$ (Effect of Side and Top Contraction)

$$Q = 2[0.6 \times 75 \times 18 \sqrt{2g(H - 0.6 \times 18)}] = 13000 \sqrt{H - 10.8}$$

for $H > 28$ ft.

add overflow to culvert flow

$$Q_{overflow} = 3.0 \times 300 \times (H - 28)^{1.5} = 900 \times (H - 28)^{1.5}$$

The results are tabulated below:

INLET CONTROL

H	Q
10	13196
12	17347
14	21860
16	26707
18	31868
20	37324
22	43506
24	47231
26	50683
28	53915
30	59509
32	67056

Next assume outlet control:

Tailwater level for given Q determined from Head-Discharge curve at Brookland Dam D/S

Headloss through bridge taken as a function of the velocity head through the bridge opening

for TW < 18' (flowing partially full) assume

$$HL = 0.6 \times \frac{V^2}{2g}$$

$$H = TW + 0.6 \times (\frac{Q}{A})^2/2g$$

$$A = 2 \times B \times TW = 150 \times TW$$

for TW 18' (flowing full) assume

$$HL = 1.4 \times \frac{V^2}{2g}$$

$$H = TW + 1.4 \ (\frac{Q}{A})^2/2g$$

$$A = 2 \times 75 \times 18 = 2700 \text{ sq. ft.}$$

$$H = TW + 2.98 \times 10^{-9} \ Q^2$$

Outlet Control - Sluice gates open at Brookland Dam

Q	TW	HL	H
2128	10	.02	10
3237	12	.03	12
5839	14	.07	14.1
12196	16	.24	16.2
21481	18	1.38	19.4
33201	20	3.28	23.3
39919	21	4.75	25.8

Comparison of the Inlet Control rating table and the Outlet Control Rating Table indicates that over the entire range of interest the flow through the bridge opening will be in outlet control, and therefore the Outlet Control Rating Table applies.

The reduction in flow for various stages is determined from the relationship:

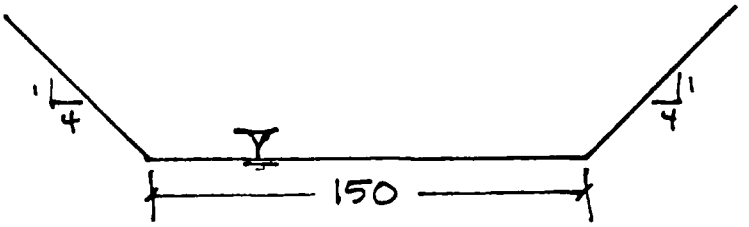
$$Q_{p2} = \text{pre-failure } Q + Q_{p1} \left(1 - \frac{STOR}{VOL}\right)$$

Where:

STOR = Reach Storage

VOL = Failure Storage released

Reach storage is determined from reach stage (above pre-failure) by assuming a 2500' reach section as follows:



$$STOR = \frac{(154\ h)\ 2500}{43560} = 8.84\ h$$

Failure storage released is determined from the stage-storage curve between the pre-failure tailwater of 885.9 feet MSL and the dam crest of 892.3 feet:

$$VOL = 725 - \frac{8.6}{10.7} \quad (400) = 405 \text{ AF}$$

Therefore:

$$Q_{p2} = 7900 + 9770 \ (1 - \frac{8.84h}{405})$$

The reduction in failure flow in this reach is computed as the balance between attenuation due to storage and available outlet capacity. This is determined as the intersection of the Q_{p2} vs. h curve and the outlet control rating curve given previously. This calculation is shown on the following page and indicates a flow reduction to 16,100 cfs with a corresponding stage of 7.6 feet above the normal pool level. No development in this reach is low enough to be subject to damage under these conditions.

The next reach downstream covers about 2000 feet between the railroad bridge and the Brookland Dam. A sketch of this control section is shown on the following page.

A stage vs. discharge rating curve for this structure is established as follows:

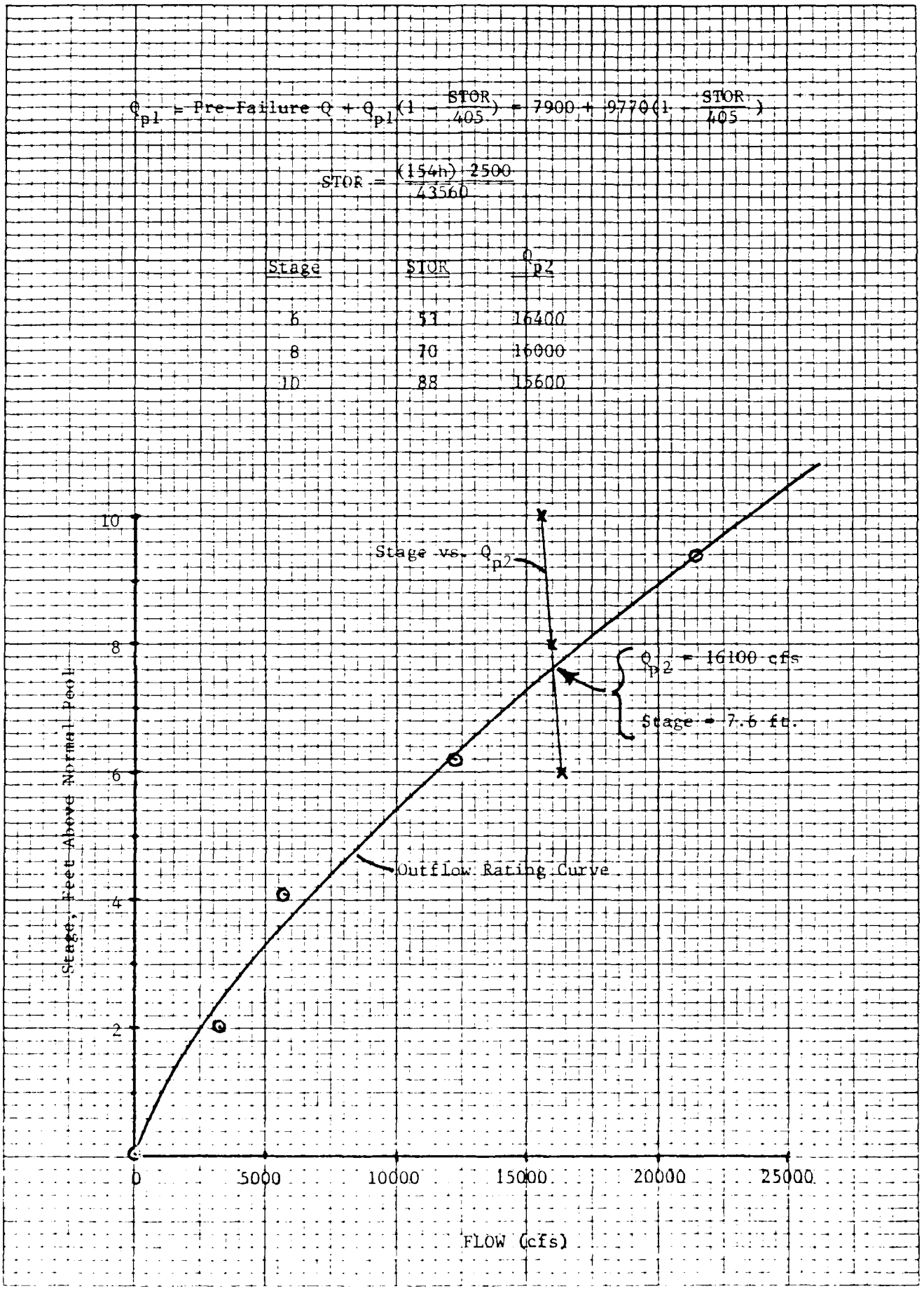
Head (H) is measured from main spillway crest

FLOW REDUCTION AT RAILROAD BRIDGE

$$Q_{p1} = \text{Pre-Failure } Q + Q_{p1}\left(1 - \frac{STOR}{405}\right) = 7900 + 9770\left(1 - \frac{STOR}{405}\right)$$

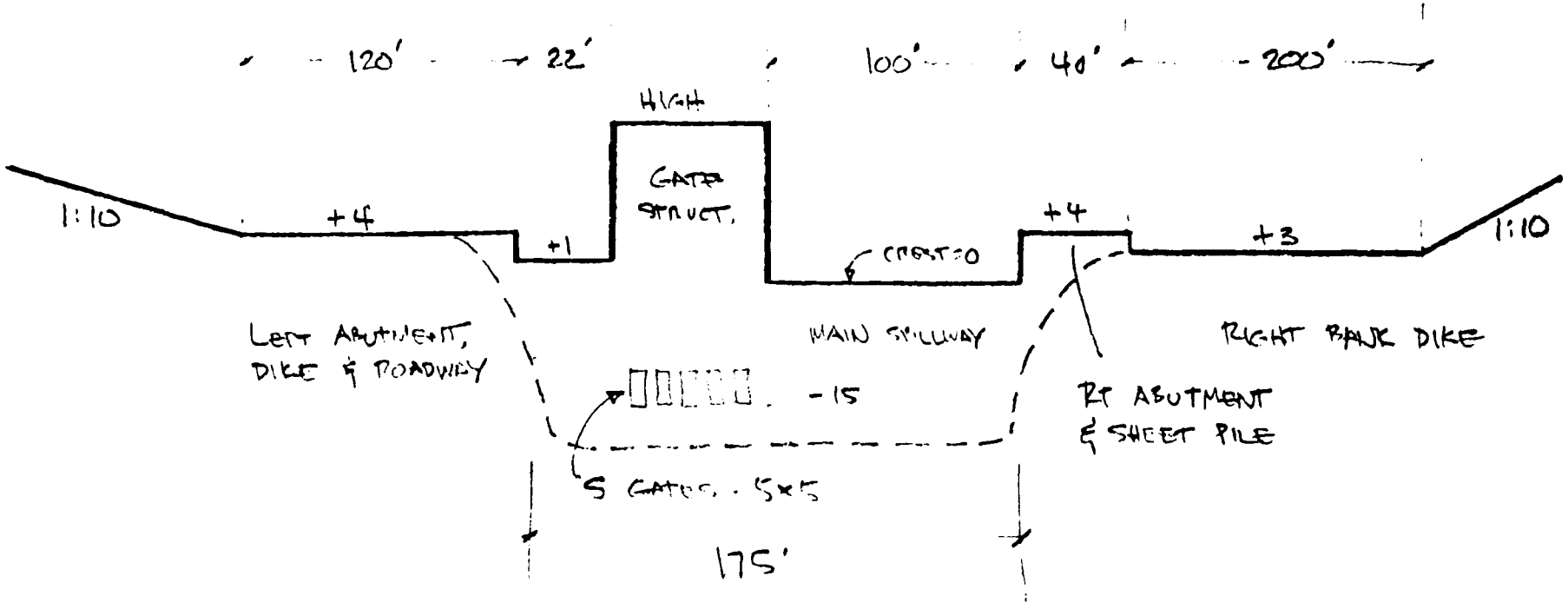
$$STOR = \frac{(154h)\ 2500}{43560}$$

Stage	STOR	Q_{p2}
6	51	16400
8	70	16000
10	88	15600



BROOKLAND DAM

(4500 Feet D/S)



1. Sluice Gates

Assume all 5 gates completely open

$Q_1 = 5[C \times A \sqrt{2 \times g \times \text{head}}]$ (Orifice equation)

$C = 0.6$ (Square edge orifice coefficient)

$A = 5 \times 5 = 25$ sq. ft.

$\text{Head} = H + 12.5$ (Head on centerline of orifice)

$Q_1 = 5 \times 0.6 \times 25 \times \sqrt{2 g (H + 12.5)}$

2. Main Spillway

$Q_2 = C\, L(\text{head})^{1.5}$ (Weir Equation)

$C = 3.1$

$L = 100$ ft.

$\text{Head} = H$

$Q_2 = 3.1 \times 100 \times H^{1.5}$

3. Left Spillway

$Q_3 = 3.1 \times 22 \times (H - 1)^{1.5}$

4. Dike at Right Abutment

$Q_4 = 2.8 \times 200 \times (H - 3)^{1.5}$

```
100 REMARK: STORED ON TAPE B1, FILE 25
110 PAGE
120 PRINT "  HEAD VS. DISCHARGE FOR BROOKLAND DAM"
130 PRINT USING 140:
140 IMAGE /2T"HEAD"30T"DISCHARGE"
150 PRINT USING 160:
160 IMAGE 1T"(FEET)"32T"(CFS)"
170 PRINT USING 180:
180 IMAGE 10T"TOTAL   GATES   SPILLWAY  ABUTMENTS"
190 FOR H=0 TO 10 STEP 0.5
200 O1=5*0.6*25*(2*32.2*(H+12.5))↑0.5
210 O2=3.1*100*H↑1.5
220 O3=0
230 O4=0
240 O5=0
250 O6=0
260 O7=0
270 IF H<=1 THEN 350
280 O3=3.1*22*(H-1)↑1.5
290 IF H<=3 THEN 350
300 O4=2.8*200*(H-3)↑1.5
310 IF H<=4 THEN 350
320 O5=2.8*40*(H-4)↑1.5
330 O6=2.8*120*(H-4)↑1.5
340 O7=2*2.8*(10*(H-4))*(0.5*(H-4))↑1.5
350 T1=O2+O3
360 T2=O4+O5+O6+O7
370 T3=O1+T1+T2
380 PRINT USING 390:H,T3,O1,T1,T2
390 IMAGE 1T,2D.2D,9D,8D,11D,10D
400 NEXT H
410 END
```

HEAD VS. DISCHARGE FOR BROOKLAND DAM

HEAD (FEET)	DISCHARGE (CFS)			
	TOTAL	GATES	SPILLWAY	ABUTMENTS
0.00	2128	2128	0	0
1.00	2521	2211	310	0
2.00	3237	2292	945	0
3.00	4173	2370	1804	0
4.00	5839	2445	2834	560
5.00	8581	2518	4012	2052
6.00	12196	2589	5319	4289
7.00	16518	2658	6744	7117
8.00	21481	2725	8278	10479
9.00	27050	2791	9913	14346
10.00	33201	2855	11644	18701
11.00	39919	2918	13466	23535
12.00	47195	2979	15375	28841
13.00	55021	3039	17365	34616
14.00	63392	3098	19435	40858
15.00	72307	3156	21582	47569
16.00	81763	3213	23802	54748

ASSUMES ALL SLUICE GATES FULLY OPEN

5. Right Abutment and Sheet Pile

$$Q_5 = 2.8 \times 40 \times (H - 4)^{1.5}$$

6. Left Abutment

$$Q_6 = 2.8 \times 120 \times (H - 4)^{1.5}$$

7. Side Slopes

$$Q_7 = 2 \times 2.8 \times (10\ (H - 4)) \times (0.5\ (H - 4))^{1.5}$$

The BASIC program used to calculate the head-discharge function is listed on page D-24, followed by tabular results.

The reduction in flow for various stages is determined as for the Railroad bridge:

$$Q_{p2} = \text{Pre-failure } Q + Q_{p1}\ (1 - \frac{STOR}{VOL})$$

$$Q_{p1} = 16100 - 7900 = 8200$$

$$STOR = \frac{154h \times 2000}{43560} = 7.07h$$

$$VOL = 405 \text{ AF}$$

$$Q_{p2} = 7900 + 8200(1 - \frac{7.07h}{405})$$

The calculation of the reduction in failure flow is shown on the following page. It indicates an attenuated flow of 15,100 cfs and a corresponding stage of 7.3 feet.

Development in this area consists of four houses in the left overbank area just upstream of the dam and six to eight more houses on the same side along the road adjacent to the dam. This region would act as an overflow section to the dam at stages higher than about 3 feet above normal (i.e., above the Brookland Dam Spillway elevation). The living areas of all these houses are about four feet above the normal pool level. On the right bank in this same area is a large paper processing plant, consisting of many individual structures. Several of these are located at an elevation equal to or less than the Brookland Dam spillway.

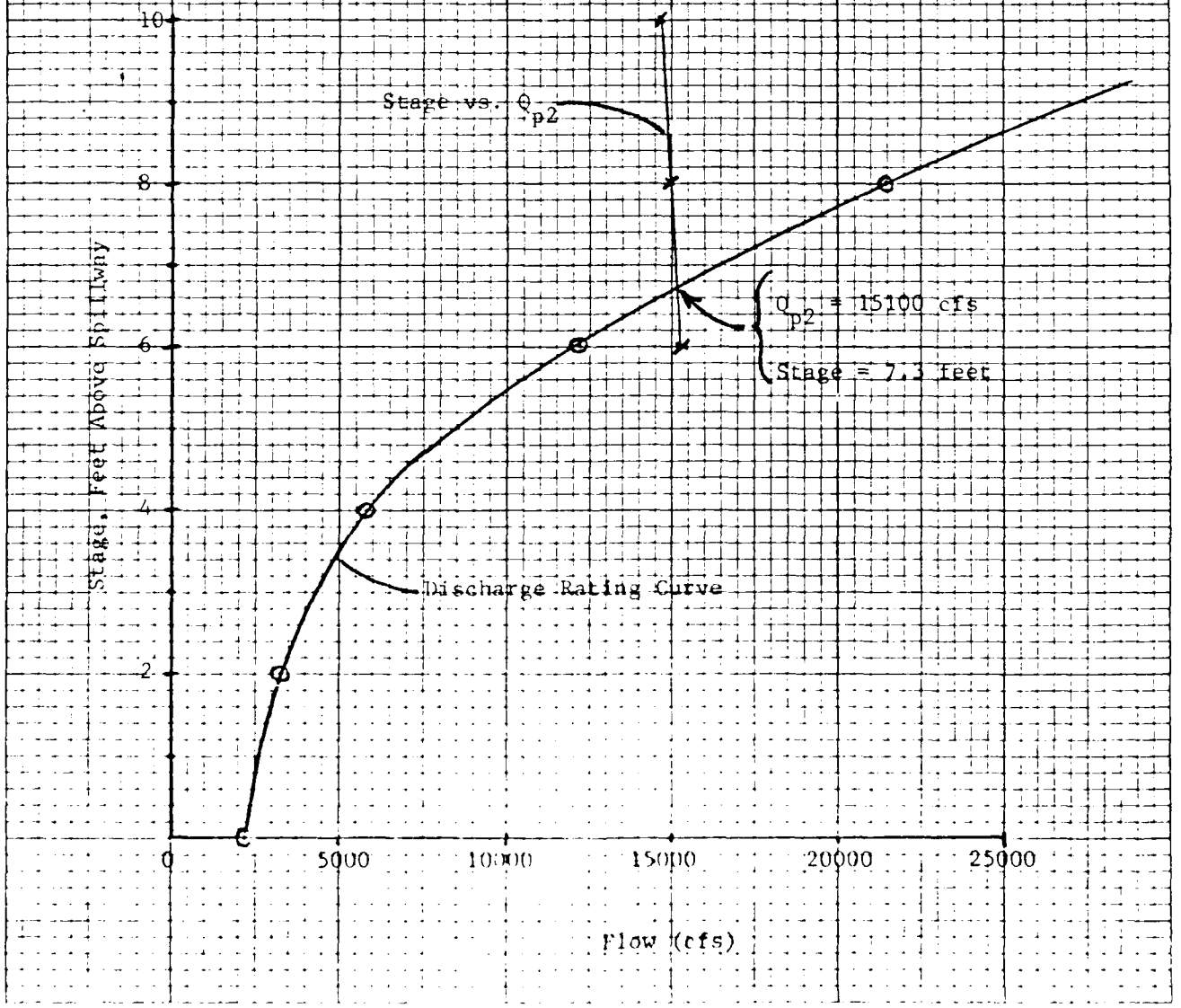
Pre-failure flooding conditions for a flow of 7900 cfs would have produced minor flooding of about one foot in depth in the houses along the left bank, and significant overtopping of the right bank dike into the paper plant complex. The failure wave would suddenly increase the depth of flooding in the residential area from about one to three feet, and greatly increase the flow through the paper plant. The additional property damage and loss of life potential due to failure would be significant.

FLOW REDUCTION AT BROOKLAND DAM

$$Q_{p2} = \text{Pre-Failure } Q + Q_{p1}\left(1 - \frac{STOR}{405}\right) = 7900 + 8200\left(1 - \frac{STOR}{405}\right)$$

$$STOR = \frac{(154h)\ 2500}{43560}$$

Stage	STOR	Q_{p2}
6	42	15300
8	57	15000
10	71	14700



Test Flood Analysis

Size Classification - SMALL

Storage = 75 AF < 1000 AF

Height = 15' < 40'

Hazard Classification - HIGH

Dam failure would result in the possible loss of more than a few lives at about a dozen houses within one mile downstream.

Test Flood Selection

From "Recommended Guidelines," the appropriate test flood for a SMALL dam with a HIGH hazard potential is between the ½ PMF and the PMF. Since the risk is on the lower side of HIGH, use the ½ PMF.

Using the guideline curves for "Maximum Probable Flood Peak Flow Rates":

Drainage Area = 247 square miles

Topography - partially "Mountainous" and partially "rolling." Rates from curves from this drainage area are:

Mountainous = 850 cfs/square mile

Rolling = 700 cfs/square mile

Use 700 cfs/square mile as representative, therefore:

$$\text{PMF inflow} = 247 \text{ square miles} \times \frac{700}{\text{square miles}}$$

$$= 173{,}000 \text{ cfs}$$

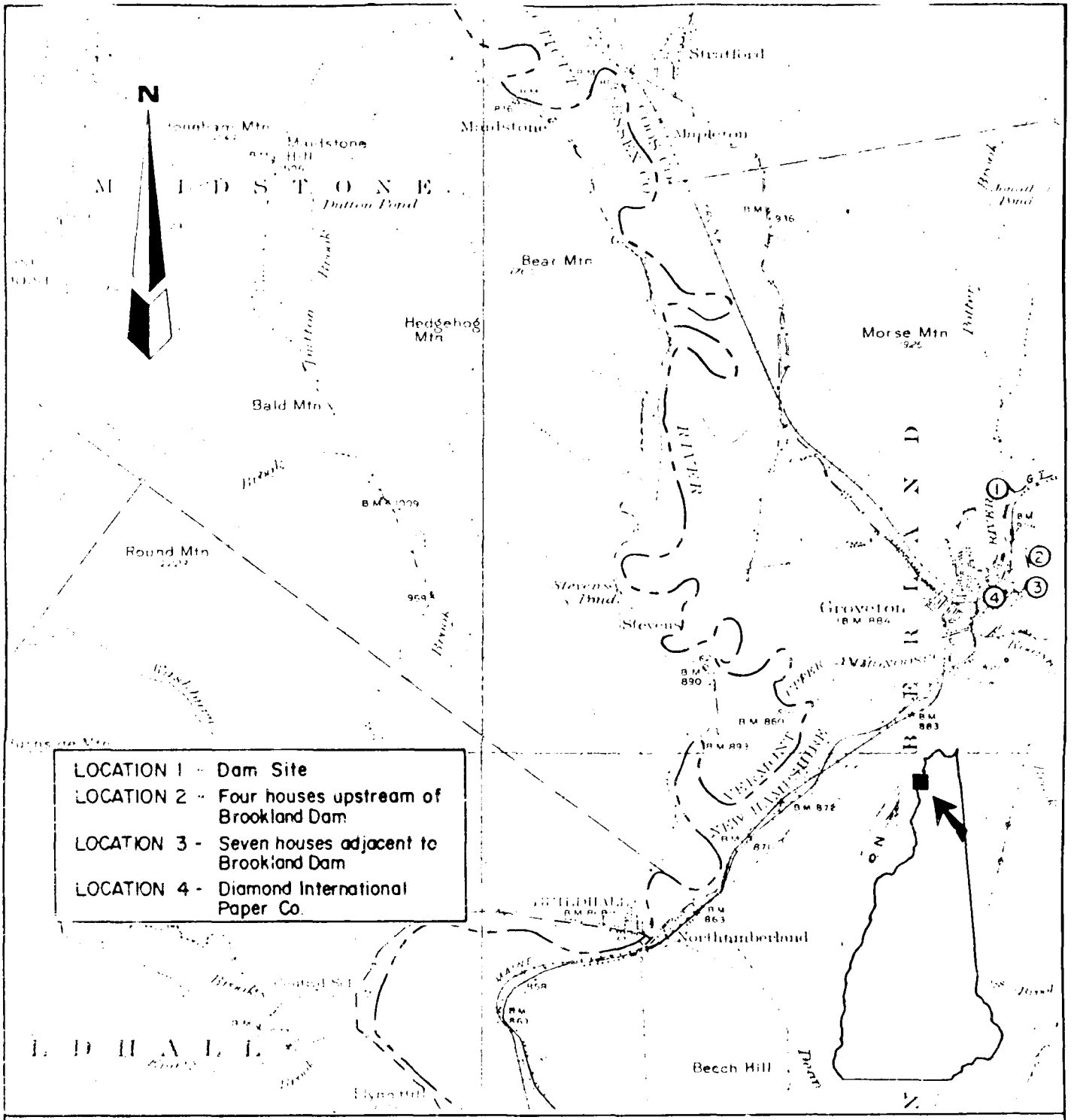
$$\tfrac{1}{2} \text{ PMF} = \tfrac{1}{2} \times 173{,}000 = 86{,}500 \text{ cfs}$$

No attenuation of large flood flows could occur in the small ponding area behind the dam. Therefore:

Peak Test Flood Outflow = 86,500 cfs

From the rating curve on Page D-7 this flow would produce a peak flood stage 19.4 feet above the spillway, or 19.4 - 4.3 = 15.1 feet over the dam crest.

$$\text{Spillway Capacity} = \frac{7900}{86,500} \times 100 = 9\% \text{ of Test Flood}$$



-SCALE-
0 1/2 1 2 (MILES)

FROM USGS GUILDHALL, VT - N.H. QUADRANGLE MAP

GOLDBERG ZOINO & ASSOCIATES, INC GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS NEWTON UPPER FALLS MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND DOWNSTREAM HAZARD MAP

FILE No. 2605

UPPER AMMONOOSUC DAM NORTHUMBERLAND, N.H.

SCALE AS SHOWN

DATE JUNE 1981

AD-A155 263 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
UPPER AMMONOOSUC DAM (.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV AUG 81

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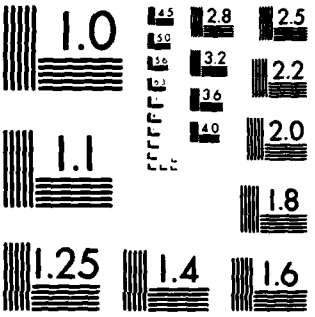

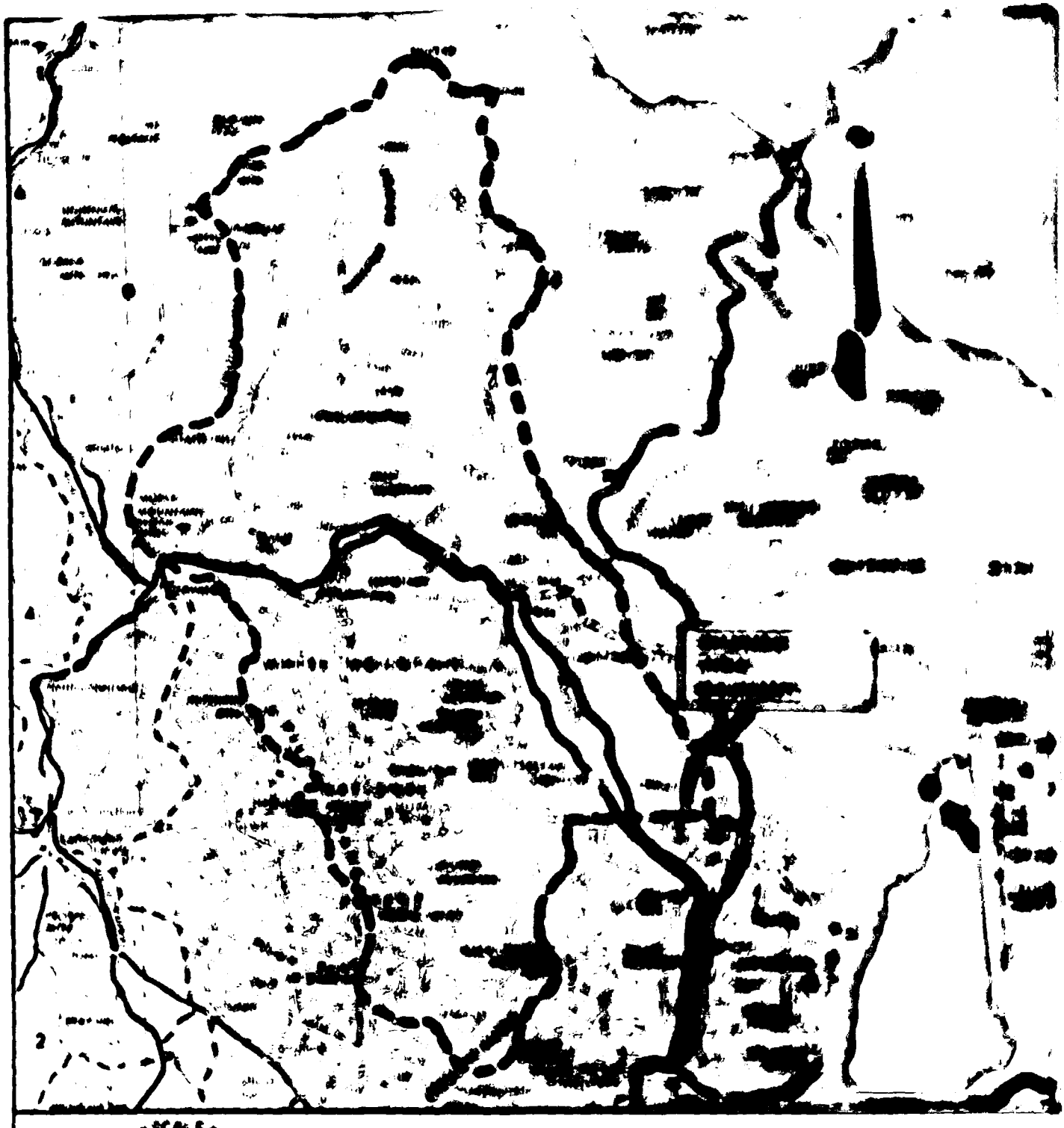

- SCALE -

FROM USGS LEWISTON, N.H.-VT.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DRAINAGE AREA MAP

UPPER AMMONOOSUC RIVER

END

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